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### THE INSTITUTE DINNER.

The Institute annual dinner will occur just after our issue has gone to press, and we must reserve our report until next week. We are glad to know that it promises to be unusually well attended, and a brilliant and memorable success, worthy the work put upon it, and the anniversaries it celebrates. We are glad to be able to extend our congratulations to Mr. Edison and the Institute upon the founding of the first electrical medal in this country associated with his name, and hope the medal will be won by many worthy recipients who will also come in due time to make their part and mark in the electrical arts.

### MANUFACTURING COMPETITION.

One of the most important recent events in electro-industrial development is the new departure of the Allis-Chalmers Company, one of the great steam engineering manufacturers of the country, to whose purpose of becoming also a leading electrical manufacturer, we give publicity this week. The corporation has great resources, has recently made notable affiliations, and now has enlisted for its electrical staff some well-known men, whose names we mention. This is a move which will be watched with deep interest and may be fraught with many consequences as to the future of the art, now broadening and widening in every direction.

### WAR IN THE EAST.

Now that war has unfortunately broken out in the Far East, it will be interesting to see what use Russia and Japan make of the modern resources of electricity as applied to warfare, both on land and on sea. The Transvaal war and the Spanish war were both rather disappointing as to the use of new devices, but we think the present struggle may furnish some lessons. The Russians have engineers with a distinct leaning to electricity, while the brave and energetic Japanese "miss no trick," in what is new and useful, whether for war or peace.

### AN INTERESTING BIT OF HYDRAULICS.

A rather unusual variation of Eastern hydraulic practice is that reported on page 305, this week, on the Bull's Bridge power plant. This new enterprise on the Housatonic reminds one in certain ways of current Western practice, yet varies from it in some important particulars. The hydraulic developments here in the East have been evolved from the early work on the large New England rivers by a process that has been upon the whole determined by provincial canons of practice as thoroughly as has been the speech of the Yankees who have undertaken the work. Lowell, Holyoke and similar cities have furnished the impetus for the investment and the work has gone on by the sole light of their experience. The articles of the Eastern hydraulic creed may not number quite thirty-nine, but their fixity puts to shame their theological prototype. A stream with a moderate fall and plenty of water, a stone dam built for time and eternity, regardless of expense, a hewn masonry canal and tail race, vertical shaft turbines with plenty of gearing, which the owners swear wastes no power at all—and the hydraulic engineer was content with the work of his hands. There have been schismatics and heretics even in New England, however—wretches who had the temerity under stress of hard times to put in crib dams that would only last a generation or two, and backsliders who tried to

wreck the foundations of the faith by objections to bevel gearing; but in the main Eastern hydraulic plants have seldom wavered in the faith save when tempted by evil-minded electricians.

In the West the pioneer in hydraulic work was the mining and irrigating engineer, bringing down to the placer diggings and to the broad acres of the valleys the melted snows of the Sierras, carrying the clear little stream a score—yes, a hundred of miles, if need be—in ditches and flumes and tunnels and inverted syphons, until he could drop it a sheer eighth of a mile or so down to the gravel banks or the sage brush deserts that turned to gardens at its touch. It was a different school from that of the East with very different lessons to be learned—but learned they were, and thoroughly. Now, here in the East we are just beginning to appreciate the situation, and as the larger powers on the older streams are taken up, to cast about for powers anywhere, with a willingness to develop them according to their needs, with little respect for tradition. And such powers as this at Bull's Bridge are the first fruits of this broader outlook. In the arrangement of the works with a long canal ending in steel pipes plunging right down upon the wheels, the situation is typically Western, even though the fall is only a beggarly hundred and twenty-five feet or so. The dam, however, is much more of a structure than is usual in Western plants and the canal follows Yankee patterns in many respects. It is something, however, to note that the dam is of rubble and concrete, a construction which is distinctly a compromise between progress and precedent. We believe in good construction, but we have here in the East much to learn as to methods of maximum economy in hydraulics. Each year is likely to see new finds among the New England and Appalachian hills and more cases for the adroit adaptation of Western methods of practice. There are a good many falls of surprisingly great head to be utilized by those far-sighted enough to pre-empt them. Most of them are relatively small, but in the present condition of electrical power transmission can be profitably developed.

### THE SERIES WOUND ALTERNATING MOTOR.

The specification of Mr. Lamme's alternating railway motor, printed elsewhere in this issue, is interesting as showing an entire absence of sensational features. The success which Mr. Lamme has reached is in the line of downright skill in designing, the union of a firm grasp on the practical requirements of the case with great technical facility at suiting means to ends. The motor as described is a simple series-wound structure with an immensely powerful armature, high-resistance commutator leads, and pole faces perforated longitudinally to break up cross-induction. To simplify the commutation the frequency is low, the voltage is kept moderate and the poles are fairly numerous to bring the rotative speed to the best working point as regards the armature alternations. Mr. Lamme has apparently found that first-class working conditions are attained only within rather narrow limits in the design, and in his patent certain approximate conditions of design form an essential part of the claims. We shall be particularly interested to see how far these somewhat stringent conditions may, in practice, affect the performance of the machine on direct-current circuits. One of the conspicuous advantages of the series-wound alternating motor is the fact that at least in theory the machine can be successfully operated on direct-current circuits, and so can be made available for the existing urban connections of interurban roads. If, however, the design from the standpoint of alternating current operation is rather closely limited, will the motor meet the full practical requirements of tramway work on the usual direct-current systems? This is, of course, a question of fact not to be answered offhand or from an inspection of the patent specification. It is safe to say, however, from the judgment displayed in the alternating-current design, that if a successful compromise is practicable, Mr. Lamme is fully competent to work it out.

### GRAPHICS IN POWER-HOUSE LOCATION.

It is a well-known proposition in the theory of electric power transmission that the electrical center of a district is its center of gravity. That is to say, if a massless plane map of the district be prepared, and at each point of load a corresponding mass be located, at the rate of say one milligramme per ampere to be supplied, then the center of gravity of all the masses, or the position on the map at which the sum total of the masses would be equivalent to the total distribution; or, again, the point on which the map, as a rigid plane, would float horizontally, if rested on the point of a vertical needle, is the center of distribution of the system for minimum copper in radial distributing conductors, arranged for uniform current density, and for any given drop of pressure in transmission. A power house should theoretically be located at the electrical center of gravity for the greatest economy of distribution. Of course, the proposition applies to an ideal case, in which land has the same value at all parts of the district, and where no natural obstructions prevent a power house from being erected; where rights of way are all alike, and where the designing engineer can lay out a distribution system as the Russian Czar is said to have laid out the Moscow-St. Petersburg Railway—with a map, a straight-edge and a pencil. It is doubtful whether such ideal conditions of electric power house location exist even beyond the skies. They never have been reported to occur on this earth. The power house can never fall on the exact center of gravity of the system. Moreover, the distribution lines are always subject to some conditions of dissymmetry. Again, the prospective loads are never predeterminable with mathematical accuracy. They are always open to a certain range of doubt, and estimation must take the place of computation to a greater or less degree. Consequently, the center-of-distribution law has about as many restrictions, qualifications and reservations, in practice, as the Kelvin law of the most economical size of conductor to transmit a given power. In theory, these laws are rigid and adamantine. In practice they are made so tortuous and flexible that their own authors would sometimes never recognize them. Nevertheless, the engineer should be familiar with these propositions. He should instinctively do obeisance to the law of the electrical distribution center, even when his mind is devoted to the numerous details of land value, water supply, coal supply, rights of way and wrongs of way.

If, however, the center-of-gravity law is powerless, in practice, to assign the most economical center of distribution from the business man's standpoint, it is at least capable of declaring when the center of distribution ought not to be located from the conductor cost standpoint. It is well, at least, to be able to determine, as closely as the load estimates will permit, where the center of distribution lies, in order to compare the location of the economy council with the location of the economy of conductor, the council being composed of representatives of land, fuel, transport, property rights and president's proclivities, along with Mr. Copper Conductor. The ordinary method of finding the center of gravity of a district is to mark off the loads on the map, then to project those loads orthogonally on any pair of co-ordinate axes, such as the edges of the map, to compute the center of gravity of these loads, on each edge separately, and to mark off the center of the map at the intersection of the co-ordinates of the centers of gravity on the edges. This process requires two arithmetical processes to be pursued, for determining the centers of gravity on the two edges respectively. The article by Mr. S. Diamant on page 311 offers an ingenious method

of solution for these two arithmetical problems without resorting to arithmetic; that is, by purely graphical methods. To some persons graphical methods are specially welcome. Isaac Newton's genius showed itself in graphics most particularly. Other persons prefer arithmetic to the pencil and protractor. But whichever method may be preferred, the graphical problem will always have interest. Mr. Diamant projects his loads upon the co-ordinate axes in the usual way, and then makes a pair of auxiliary diagrams. These diagrams lead to certain angular relations between lines definitely related to the lines of load. By working with these angles on the edges of the map, the two centers of gravity are arrived at without computation. Whether this geometrical solution is known in mechanical graphics we are not informed; but the geometrical proposition seems to be new in electric technology.

### RADIATIONS EMITTED BY A RIGHI VIBRATOR.

In the last number of the *Physical Review* an interesting series of measurements is reported by Messrs. Willard and Woodman on the radiations emitted by a Righi vibrator. A Righi vibrator consists essentially of four metal balls in a line, with three spark-gaps between them. The middle spark-gap is usually in oil. The balls are ordinarily small, like large-sized marbles, and the waves that such a vibrator emits when the extreme balls are suddenly electrified or discharged, are about as short as can be conveniently produced. Sometimes the inside pair of balls are of larger diameter than the outside pair, and sometimes only three balls are used, one big one in the middle and two little ones, at opposite ends of a diameter. There is a great difference of opinion as to the nature of the waves emitted when the electric system is struck. Some contend that the system emits all wave lengths, in a continuous spectrum, and that the particular waves which affect the resonator are selectively determined by the dimensions of the latter. Others believe that the vibrator emits waves of definite length—that is to say, of a length which has a definite geometrical relation to the size of the vibrator—but that, owing to the highly damped nature of the vibrations, or their rapid diminution and decay, the wave lengths appear to cover a wide range. One school supports the theory of a continuous spectrum; the other supports the theory of a simple spectrum with a line or lines like a gas spectrum.

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When the vibrator attains a considerable length, as in the antennæ of wireless telegraphy, the theory of wireless telegraphy has long pointed to the existence of a fundamental wave, of four times the height of the mast, or twice the length of the antenna with its "image" below the ground. Upon this fundamental should exist an indefinite number of harmonics like those of an excited musical string. The number and prominence of the harmonics depend upon the particular detail conditions of excitation. In general, the bulk of the energy is carried by the fundamental waves. If Righi vibrator radiations resemble wireless antenna vibrations, then the line spectrum theory is favored rather than the continuous spectrum theory, assuming that there will be a plurality of lines, in harmonic or simple multiple relationship. The Righi vibrator is, however, not the simplest type of vibrator, and it seems possible for some complications to exist in its vibratory system. The measurements of Messrs. Willard and Woodman show that the waves emitted had pronounced fundamental wave lengths and also distinct harmonics. At the same time the measurements show that the dimensions of the resonator materially affect the received energy. So rapid is the damping of the waves emitted by the vibrator that the waves may almost be regarded as single impulses, with an insignificant trail. This simple impulse, striking the resonator, sets the latter in vibration according to its own frequency and wave length. Consequently, the tuning of the vibrator to the resonator has much less effect than if the resonator emitted a continuous train of waves.

### THE SPIRIT OF TECHNICAL EDUCATION.

Some time since, in commenting on President Butler's proposition for a two-year college course, we expressed the opinion that so far as success in technical callings was concerned, education ought to be broadened rather than narrowed. So far as the mere acquisition of facts is concerned, systematic perusal of a modern technical journal will furnish more raw material than the average course of instruction in a technical school, but we would be the last to insinuate that the former renders the latter unnecessary. What the successful engineer wants is power and facility in using the raw material that he finds at hand, and this can be acquired only by a wide and thorough intellectual training. Its scope and character is of far less importance than its thoroughness. We do not wish to make invidious comparisons between institutions, but we know of none which have furnished a large number of brilliant engineers in various departments compared with the total number of graduates than the United States Military and Naval Academies. These men were trained not in the so-called practical details of modern engineering, but in the art of war, but so trained that their mental and physical powers were under full command for what they might be worth. It is the foundations which count, and the wider and deeper these are laid the better. Hence, we regret any tendency to scamp the preliminary work of building an education and character. An engineer needs them both to be fully equipped for his part in the world's work. We in America have come in these latter days to the parting of the ways in technical education. We have swept rapidly along, making tremendous material progress, and gaining a swift adaptability in grasping the ideas which had been accumulated by many hands in unpractical and unapplied research. Now, the choice lies between lending a hand in this very research and scurrying about in the hope of getting some one to do the work for us.

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Scientific education had in earlier years a hard battle for existence. It was crowded into corners and shoved into alleyways by the mental luggage of centuries past. To grow, indeed to live at all, it had to take the aggressive, to play the iconoclast, and to push aside the dust-covered impedimenta that were in the way. All this was well, but with the rapid accession of material results has come a certain contempt for the eternal house of learning in which it must forever dwell. The result has been that American technical education has laid too much stress upon the acquisition of bare facts, a knowledge as dead and unfruitful of intellectual growth as a defunct language. For these facts, however important in themselves, are the fruits of others' sowing, and the acquisition of them merely the diligence of the unthinking gleaner. So long as the pickings are good, the gleaner flourishes, and in course of his hum-drum task he may sometimes gain the skill of the husbandman; but it is in spite of his labor not because of it. Permanent supremacy comes only with a deeper kind of culture, and toward that the efforts of the coming generation must be directed. We are moved to this defense of the foundations of specialized knowledge by the recent announcement that three distinguished professors in Columbia University have offered their resignations in protest against the brushing aside of the culture courses which they represent. We do not know either the gentlemen affected or the full merits of the issue which has been raised; but this we do know, that when general culture loses its grip on undergraduate instruction, post-graduate instruction is in the long run the loser. In this world of hard work a man to win material success must be able to do some one thing better than his fellows—must know one thing more thoroughly; but to make that thing worth the knowing and the doing and to give that success a value to mankind, he must have learned the relation of both to humanity.

## Entrance of Allis-Chalmers Into Electrical Field.

One of the most important and far-reaching events of recent years in the field of industrial electricity is the entrance into it of the Allis-Chalmers Company. With regard to this action on the part of this well-known concern, respecting which rumors have been in circulation so long, no further doubt appears to exist, and thus one of the most formidable oppositions which the existing great manufacturers have had to encounter takes shape and organized form. The creation of this new competition would appear to have been inevitable from the standpoint of the Allis-Chalmers people, and the present movement may be said to date back to the entrance of the General Electric Company into the steam turbine field, and to the action of that important concern in selling its dynamos and steam turbine units as a complete generating plant to the entire exclusion of the reciprocating engine with which the fame and reputation of the Allis-Chalmers Company have been so closely associated in the past. It is understood that the Allis-Chalmers Company expressed to the General Electric Company their willingness to undertake in its behalf the manufacture of the steam turbine in large shops already well equipped for such work, leaving to the General Electric Company the manufacture of the electrical part of the combination; but these proposals, if made, were evidently not accepted. Finding themselves thus cut off by the General Electric and Westinghouse production of steam turbines as well as generators, from a very large portion of the work which had constituted no slight share of its business, the Allis-Chalmers Company have determined to redress the balance of things by entering the electrical field for the production of heavy machinery, believing that with unsurpassed mechanical experience, with all the heavy apparatus free from patent litigation, and with the command of some of the best electrical engineering talent in the country, and with energy and good judgment, it might well make itself in a short time a very formidable factor.

We understand, therefore, that the Allis-Chalmers Company are to take up immediately the manufacture of heavy electrical generators for the largest class of work and are at once entering that field. In addition to this, and supplementing their well-known reciprocating engines, they are, after two years of very careful research, also prepared to supply a steam turbine which is in efficiency equal to the very best known in Europe. They have also, as noted recently in these columns, taken up the manufacture of one of the largest and best-known types of gas engine—the Nürnberg—and have now secured from the famous Swiss firm of Escher, Wyss & Company, who designed the Niagara turbines, the exclusive rights for the manufacture of their hydraulic turbine, of whose experience and plans they will derive the full benefit.

One of the first steps in connection with the new departure has been the creation of an electrical department, in regard to which work is now going forward. At the head of the engineering staff will be Mr. John F. Kelly, so long and so favorably known in connection with the Stanley interests. He will be the active engineer in the company so far as electrical matters are concerned, as its electrical director, but associated with him in an advisory and consulting capacity will be Mr. William Stanley, Jr. It will be readily recognized that in these two gentlemen the company has acquired the services of some of the very best talent now available.

A great many details with regard to this momentous action are not yet ready for publication, but we understand that Mr. Kelly has been busy both at the company's works at Scranton and at their Western shops in making plans which will give immediate effect to the campaign of development along electrical lines, which the executive officers of the company have carefully laid down. We expect in a short time to be able to give some further details in regard to this matter.

## Warships and Wireless Telegraphy.

A Washington dispatch states that a series of tests of four systems of wireless telegraphy will soon be made by warships in the vicinity of New York. The progress of wireless telegraphy in the navy recently is considered to have been very satisfactory. In one case the flagship *Kearsarge* and the *Minneapolis* communicated with each other by the wireless method at a distance of sixty miles.

## The Pupin System Validated in Germany.

Dr. Michael I. Pupin, who recently went abroad to attend the final argument on the opposition to the granting of a German patent upon his loaded conductor, reports by cable a sweeping victory. The case has attracted wide attention. The patent will issue to the Siemens & Halske Company. The opposition was entered by several rival manufacturers of cables and by the postal administration of Germany, which claimed to have anticipated the invention with certain experiments with loaded conductors.

It is interesting to note the thoroughness with which the invention has been investigated by the German Patent Office. The experimental tests which formed a part of this investigation are reported very fully in Electrical World and Engineer, December 27, 1902. They demonstrate the correctness of Prof. Pupin's theoretical deductions as to improvement in transmission resulting from introduction of the coils or loads into the conductor, and the essential conditions of distribution of the coils with respect to the wave length. The prior art was exhaustively collected and considered by the German examiners. The granting of the patent is, among other things, their answer to Heaviside's claim, put forth in the "Encyclopædia Britannica," that he and not Prof. Pupin made this invention. In his article on "Telegraphy" Heaviside says ("Encyclopædia Britannica," Vol. XXIII, p. 218):

"Telephone wires in air, for long-distance telephony, should have $L$ as large as possible. . . . The difference between $L = 2$ and $L = 20$ or 30, which is produced by separating the wires, is enormous, and largely multiplies the distance over which telephonic waves can be carried.

"But it is the improvement of signaling through cables that is most important, if it can be done. . . . The writer invented a way of carrying out the principle other than uniformly, and recommended it for trial; viz.: by the insertion of inductance coils in the main circuit at regular intervals, say one per mile, according to circumstances. The time constants of these coils should be as large as possible, so that the average inductance may be largely increased without a large increase in the average resistance per mile. The action of the coils is similar to that of small detached loads placed upon a string to give it inertia, and enable it to carry waves further. If we wish to imitate a curve containing bends of various sizes by means of dots, it is obviously necessary to have several dots in every bend. So in the substitution of detached inductances for uniform inductance, we need to have several coils in every bend of the electrical wave. It is easy to say that so many coils will be wanted in such a length, in telephony, for example, if we can fix upon the shortest wave length, by using the known formula for wave length. One could do that without being considered to make a new discovery. But this does not answer the question how few the coils may be for telephony through a cable. Theoretically, we want an infinite number, i. e., uniform inductances. We must sacrifice something. The shortest telephonic wave length necessary to be considered is a doubtful element, and there are unmentioned interferences to be allowed for. Hence, experiment alone can decide how few the coils need be for telephony through a distance far exceeding that possible without the coils. Nothing particular has been done in Great Britain to carry out the writer's invention, but in America some progress has been made by Dr. Pupin, who has described an experiment supporting its practicability; the length telephoned through was increased five times by inserting the coils."

Heaviside's suggestions, upon which he places so much reliance, are interesting. But on the whole they are surpassed in importance, as they were preceded in time, by the researches of the late A. Vaschy,[1] an engineer of great eminence, connected with the telegraphic and telephonic service of the French Government.

Both Vaschy[2] and Heaviside[3] illustrated the beneficial effect of high inductance by the analogy of the mass of vibrating strings. Neither seems, however, to have noted the bearing of the Lagrangean problem of the loaded string upon the problem of the loaded conductor, Heaviside's suggestion to the contrary in the "Encyclopædia Britannica" notwithstanding. Prof. Pupin was the first to point out this analogy, and he first extended Lagrange's famous solution to cover a case involving forced oscillations or dissipative resistances.

In disposing of his foreign rights to the Siemens & Halske Company, Dr. Pupin considers that he has placed them where no exploitation would be attempted excepting strictly in accordance with the highest commercial standards. The company deserves congratulation, as well as Prof. Pupin, as the great and recognized ability of its engineers have contributed largely to the final outcome of this long contest.

[1] Annalles Telegraphiques, 1884, 1888, 1889.
[2] La Lumiene Electrique, 1887.
[3] Electromagnetic Theory, Vol. 1, p. 215.

## High-Pressure Power on the Housatonic.

ONOTA and Pontoosuc Lakes, in Pittsfield, Mass., are the head waters of the Housatonic River, which, after crossing the State of Connecticut, flows into Long Island Sound a few miles east of Bridgeport. In its course of 123 miles the river drops 983 ft., between the lakes and tidewater, and affords numerous opportunities for the development of water power.

Over much of its course the Housatonic has carved out for itself a narrow valley whose rocky sides rise abruptly from almost the water's edge and tower hundreds of feet above its surface. Such a combination of natural features affords excellent opportunity for the development of water power under high pressures. Years ago Nicholas Staub, of New Milford, Conn., a town in that part of the Housatonic valley just considered, saw that a great water power might be developed there, and secured a charter from the State Legislature that granted important rights for this purpose, in 1893. After years of negotiation this charter passed into other hands, capital was interested, and in the spring of 1902 work on the great power development at Bull's Bridge, that is now to be described, was begun by the New Milford Power Company.

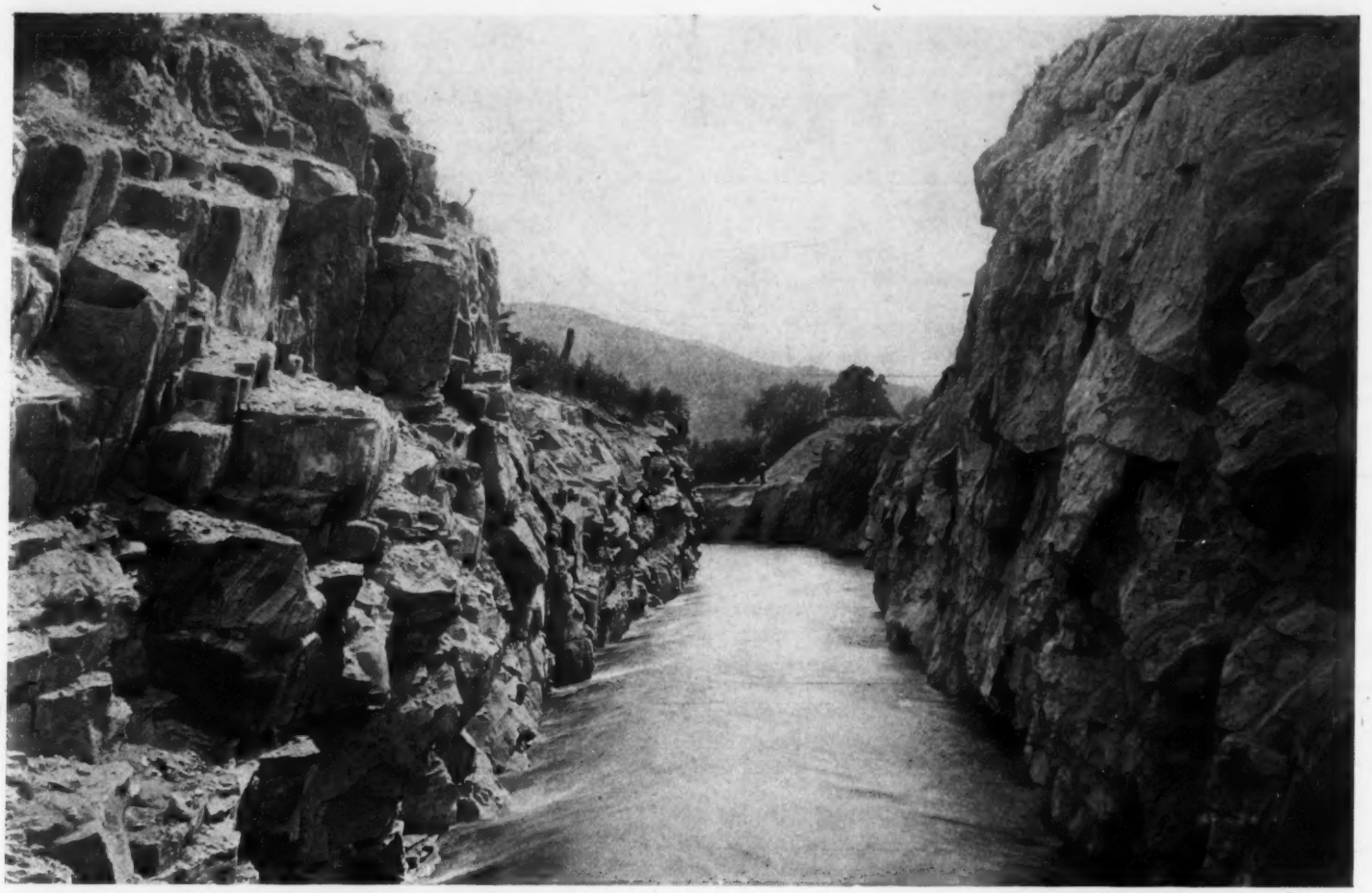


FIG. 1.—WATER IN THE DEEP CUT OF THE CANAL.

Bull's Bridge is the site of a highway crossing over the Housatonic River in the town of Kent, and is in that part of the valley where the river has a continuous rapid descent with steep, rocky hills close on either side. To reach the bridge a drive of several miles from the railway depot in Kent is necessary. Near the bridge the valley narrows and the river has cut its way down into solid rock. Below the bridge the river makes a turn of nearly 90°, and then, after flowing nearly straight for about a mile, takes another turn that brings its general direction back to within a small angle of its former course. At a short distance above the bridge a dam has been built across the river, and a canal starting from one end of this dam skirts the hillside for a distance of about two miles, and then terminates in a forebay, where the water stands about 110 ft. above the surface of the river below at the second bend above mentioned. From this forebay a steel pipe carries the water down the steep hillside to the power station on the river bank. This type of water power development, comprising a rather long canal, a moderate volume of water and a gradual fall in a river concentrated at a single point, so as to give a head of one to several hundred feet, is quite common in California, but has seldom been attempted in New England. There is reason to think, however, that water power plants of this sort will yet come to be of importance in the east.

At the point selected for the main dam on the Housatonic the bed of the river narrows down to a width of approximately 80 ft. between high ledges of solid rock, though the width just back of the dam is fully twice this distance. In this admirable situation a solid concrete dam has been laid between the ledges that form the banks of the river and sunk into the natural rock of its bed. This dam is curved in form with a radius of 88.5 ft. at the toe, 104.6 ft. at the crest and 110 ft. at the back or upstream side, the common center of the arcs being near the middle of the river down stream.

At its base the width of the dam is 34.5 ft., and 8 ft. of this width in the part directly below the crest is recessed to a depth of 2 ft. into the solid ledge of the river bed. The toe of the dam is sunk about 3 ft. below the surface of this same ledge. In height from the lowest part of its bed to its crest the dam measures 24 ft., and at the level of the top back edge, which is 1.5 ft. below the crest, the thickness of the dam is 9.5 ft. From bank to bank at its back face the arc of the dam is about 97°, and the toe of the dam is about 80 ft. long. This dam raises the river level and causes it to overflow its banks for a distance of nearly four miles up stream. This raise in the river throws its water into the bed of a small stream called Spooner's Run-Around, as this bed comes close to that of the Housatonic River at a point several hundred feet above the main dam. A few hundred feet below the main dam the bed of the run-around again joins the river. To prevent the escape of water by way of this run-around, save when the river is nearly up to the top of the main dam, a weir dam has been thrown across the lower end of the run-around. This auxiliary dam is 150 ft. long at its crest, which is a straight line, is 10 ft. wide at the crest level, and 25.5 ft. wide at its base.

In elevation the crest of the dam at the head of the run-around is two feet less than that of the main dam across the Housatonic River, so that ordinarily water will flow over the smaller dam before the river reaches the top of the main dam. Flashboards are provided, however, for the smaller dam, which raise its crest line to the same level as that of the larger dam, when desired.

The main dam is built of large stones and cement concrete, the stones being so placed that there are at least six inches of concrete between them. On both the face and back of this dam the layer of concrete is from one to two feet thick outside of the large stones that go to make up its core. For a distance of about six feet below its crest the main dam is entirely of concrete and the same is true for about seven feet of its width at the toe. From this it will be seen that this dam is a continuous mass of masonry throughout.

Another type of construction has been followed in the smaller dam at the head of the run-around, which has a vertical layer of concrete two feet thick on its up stream face, next to this a rubble wall three feet thick, and then a rock-filled interior, the whole being covered with a layer of cement concrete. This layer of concrete is about one foot thick over the top and down stream face of the small dam and extends some five feet beyond the rock filling at the toe. To provide for the escape of any water that may find its way into the rock filling of this dam, where no mortar or concrete was used between the stones, one or more iron pipes have been set into the concrete covering of the dam near its toe. A short distance below the main dam there is a natural fall over a ledge of rock in the bed of the Housatonic River, and near the foot of this fall the elevation of the water surface is about 44 ft. below the crest of the main dam. The remainder of the fall between the surface of the water in the forebay and the tail water at the power station is obtained through the gradual drop of the river bed. It is estimated that the operation of the power station at full load during a period of twelve hours will lower the pond created by the main dam only one foot in water level.

FIG. 2.—MAP OF BULL'S BRIDGE AND BOARDMAN'S BRIDGE WATER POWERS.

Before work could be commenced on the main dam the section of the canal nearest to it was blasted out of the solid ledge, and a cofferdam was built across the Housatonic at a point a little above the site of the dam so as to force the entire flow of the river into the canal. After flowing about 600 ft. in this rock section of the canal the river returned to its natural bed through waste gates. The cofferdam employed to divert the river into this canal was of a construction rather novel in the East, though it has long done effective work in the West, especially along the Mississippi River, where it has been necessary to resist the eroding tendency of the Father of Waters. In this construction the cofferdam is made up of small saplings or brush made into fascines, as they are called, placed with tops up stream, and in alternate layers with heavy stones. Over the completed mass of brush and stone an outside layer of earth is placed. The cofferdam built in this way near Bull's Bridge resisted several floods on the Housatonic when the water went over the top of the dam for days together. The only apparent effect of this flow of water was to wash a few inches of earth from the top of the brush and stone. The rock section of the canal just mentioned begins about 30 ft. from the east end of the main dam, and is separated from it by a high ledge, as may be seen from one of the photographs. This first rock section of the canal is about 600 ft. long from the river to the point where the entrance gates and waste gates are located. At its river end the stone floor of the canal is 17 ft. below the crest of the main dam, and 15 ft. below the crest of the weir dam at the head of the run-around, so that water will flow through this part of the canal with a depth of 15 ft. In cross section this portion of the canal is 25 ft. wide and has a depth of not less than 17 ft. with vertical sides, though the depth is much greater than this in some parts of the cut. The cross section of water flowing through this rock cut will be 375 sq. ft. when the flowage line is up to the top of the small dam at the run-around.

At about 600 ft. from its river end the canal widens out into an entrance chamber, and here the flush, waste and entrance gates are located. The waste gates, of which there are two, are located at the down-stream end of a spillway on the side of the canal next to the river. This spillway is about 150 ft. long and its elevation is the same as that of the crest of the main dam. Each of the two waste gates is built up with 9-in. square hard pine timbers bolted together, and closes an arched opening 10 ft. wide and 8 ft. high in a concrete pier that carries vertical guides of heavy timber. Each gate is divided into two equal parts horizontally, so that one-half can be raised without raising the other. At each of these waste gates the elevation of the arch floor is about 2.3 ft. less than that of the canal floor. The concrete pier that carries these two waste gates has its top 28 ft. above the floor of the arched openings in its base, and 10 ft. above the crest of the main dam. Next to the waste gates comes the flush gate, which is 16 ft. wide, and has its top edge at the same elevation when in normal position as the top of the main dam. The floor of the opening closed by this gate is 2.5 ft. below the crest of the main dam, so that by lowering this gate an opening from nothing up to $16 \times 2.5 = 40$ sq. ft. may be provided for water that is just up to the crest of this dam.

The Housatonic River is subject to severe freshets, owing to the rapid descent of its bed and the precipitous nature of the territory through which it flows. To provide for these freshets the large capacity of spillways, flush gates and waste gates has been made. When the river is only moderately full its entire flow is intended to pass into the rock cut of the canal which has an area in cross section of 375 sq. ft. up to the normal flowage line, which is on a level with the top of the smaller dam, but is two feet below the top of the main dam. When the river has risen to just the crest of the main dam, the cross section of water discharged over the smaller dam will be $2 \times 150 = 300$ sq. ft. Opening the flush gate adds $2.5 \times 16$



FIG. 3.—ENTRANCE GATES IN FRONT, FLUSH AND WASTE GATES AT RIGHT.

$= 40$ sq. ft. to this discharge area, and full opening of both the waste gates gives $8 \times 10 \times 2 = 160$ sq. ft. more. The total of these discharge sections amounts to 500 sq. ft., to which must be added $24.4 \times 2 = 48.8$ sq. ft. to account for the rise of 2 ft. in the flowage line of the canal. It thus appears that the total cross section of discharge in time of freshet may be $548.8 + 375.0 = 923.8$ sq. ft., or nearly 2.6 times the normal canal area of discharge, before any water goes over the main dam. As the freshet water rises above the crest of the main dam, the length of the discharge line, over and above the openings at the discharge gates, becomes 150 ft. for the smaller dam, plus about 200 ft. over the main dam, plus the 200 ft. of spillway at the side of the canal next to the waste, plus the 16 ft. at the flush gate, a total of 566 ft.

The canal entrance gates set squarely across the entrance chamber next to but at nearly a right angle with the plane of the flush and waste gates. Four entrance gates, each of heavy timber, moving in

wooden guides, are provided, and like the former gates are provided with hand-operated raising and lowering gear.

Certain portions of the canal below the entrance gates are provided with spillways on the side toward the river, so that their total length along the canal amounts to about 1,000 ft. In some parts of its course of about two miles the canal is built entirely in earth, and in such cases the area of cross section up to the normal flowage line is 450 sq. ft. The normal depth of water in this cross section is 14.6 ft., the width of the bottom of the canal is 8.9 ft., and the side slopes are 1½ to 1. These slopes are paved with heavy stones to a depth of 2 ft., and this paving runs up to an elevation 2 ft. above the crest of the main dam. As the canal for much of its

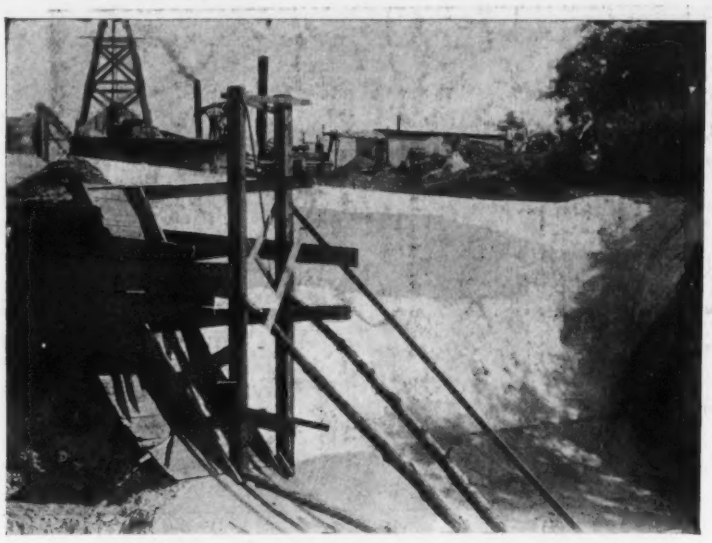


FIG. 4.—SECTION OF DAM, BULL'S BRIDGE.

length runs on a side hill, a cut on one of its sides and a fill on the other was necessary in some of its sections, and the same section is often partly in rock and partly in earth. At two points in its course the canal encounters comparatively low ground, and in these places it widens out into ponds with dikes to prevent the return of its water to the river. These ponds add somewhat to the storage capacity above the main dam.

At the forebay on the hill above the power station the canal

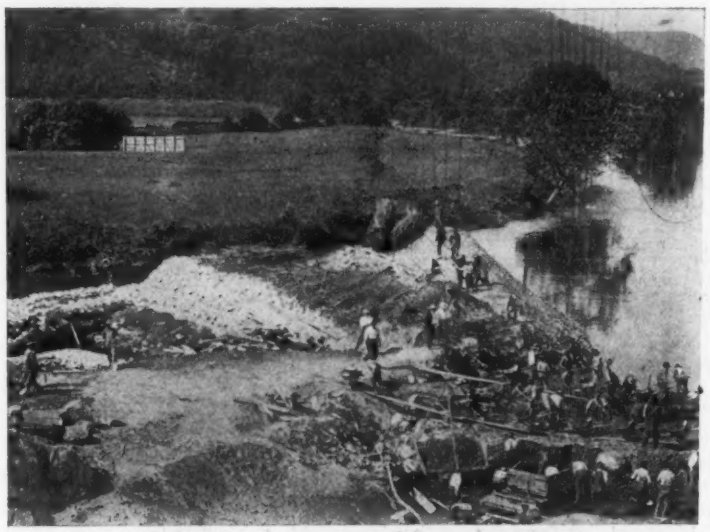


FIG. 5.—BRUSH AND STONE COFFERDAM, BULL'S BRIDGE.

widens into an entrance chamber that is 60 ft. broad at the racks. These racks are about 20 ft. high and have a slope that amounts to 4 ft. in horizontal projection. About 21.5 ft. in front of these racks and separated from them by a heavy framework are the gates that close the ends of the steel pipes which run down to the power house. Each gate is built of hard pine timbers and is in two horizontal sections that can be moved independently. Concrete forms the floor of the entrance chamber, and the head and wing walls of concrete on three sides of this chamber are 7.5 ft. across on top at their thickest points. Where the base of the head wall joins its concrete foundation its thickness is about 18 ft. The top of these walls is two feet higher than the crest of the main dam. Hand-operated gearing for moving the gates is located on top of the head wall. In this wall provision has been made for two steel pipes to convey water down to the power house, one of these to be of 8 ft. and the other pipe of 13 ft. diameter.

The 13-ft. pipe is already in position, and the 8-ft. pipe will not be erected until some future time. This 13-ft. pipe, after reaching the power house, runs along outside of its river front, and connects with seven smaller pipes that pass through the wall and to the water wheels inside. At the end of this horizontal section of the main pipe, which shrinks in diameter as pipes for the wheels are taken off, it turns into a vertical position and extends to an elevation equal to that of the crest of the main dam. The standpipe thus formed acts to relieve any undue pressure such as might be caused by the hydraulic ram action following the shutting of some of the wheels too quickly.

Inside the power house are six main generators and two exciters, each direct-connected to its own set of horizontal wheels. Energy from the six alternators will be raised to a pressure of about 30,000 volts, and then transmitted to Waterbury, New Britain and other cities of Connecticut, there to be used by electric lighting and railway systems.

All the above hydraulic work has been designed and constructed under Mr. W. S. Morton, chief engineer of the New Milford Power Company. The president of this company is Mr. Robert N. King, who has previously developed large water powers for electrical transmission on the Apple River, in Wisconsin, and on the Hudson River, at Mechanicville, N. Y. Mr. King and Mr. Morton have been associated in some of this earlier electrical work.

## Melting Out Frozen Water Pipes Electrically.

During the recent intense weather the method of thawing out frozen water pipes electrically was undertaken successfully at Altoona, Pa. Mr. E. B. Greene, the well-known superintendent of the Edison Electric Illuminating Company of that city, who has been conducting this still novel and interesting work, writes us as follows concerning practical results:

We use for this purpose alternating current of low voltage, the maximum voltage not being over 50. The method of doing this, as you know, originated with Messrs. Jackson & Wood about the year 1900, so you will appreciate that it is not new with us. We use a 25-kw transformer wound for 50 volts, using an amperemeter to know what quantity of current we are using, and reduce the voltage with a water rheostat, using common table salt to impart the necessary conductivity.

The transformer, water rheostat and instruments are assembled in a box which is hauled out to the place desired to use, when the transformer is connected up to run as in ordinary methods of lighting, using the water rheostat on the primary side of the transformer (as this requires a very much smaller vessel for the water rheostat). The secondary, or low-voltage cables, are connected directly to the spigot or to the pipe inside the building, the other one being connected to a fire plug, or, if more convenient, to the pipe in an adjoining house, which then completes the circuit on the iron pipe for the low potential.

We have thawed 250 ft. of one-inch iron pipe in twenty minutes actual time of current on, using between 18 and 20 kw. In smaller services, say ¾-in., and on 30 or 40 ft., we have thawed out in from five to eight minutes, using about 11 to 15 kw. The apparatus is very small and it is quite a convenience to people to have water, when their pipes are frozen, in two or three hours after asking to have the apparatus connected up. There is, of course, very little business in the sale of current in connection with the above, but the advertisement we get from being able to help out people who don't have water we think will repay us amply for the trouble and the expense entailed.

As you, no doubt, can see from the above the cost of sending out the transformer, the time of the men connecting up and disconnecting, and the draying charges would leave very small margin unless you would charge an excessive price, which we don't believe it pays us to do. The cost varies very much. The cheapest job, which was near by the station, was $2.50; the most expensive one was $9.50; yet the amount of current used is a very small amount as compared with the charges for labor and drayage.

## The Frequency Changers at Montreal.

By B. A. Behrend.

THE City of Montreal, Quebec, obtains electric energy for power and lighting from three plants, which have three different frequencies. The Chambly power plant supplies alternating current at 66 cycles, the Lachine Hydraulic Land & Power Company generates alternating current at 60 cycles, and the Shawinigan Water & Power Company generates alternating current at

FIG. 1.—SUB-STATION AT MAISONNEUVE.

30 cycles. Since the consolidation of these three plants a compromise frequency of 63 cycles has been adopted.

At Shawinigan Falls there are installed two 3,750-kw generators operating at 180 revolutions and 30 cycles and generating 2,300 volts of two-phase current. By means of transformers the two-phase current is changed to three-phase current of 55,000 volts, which is transmitted from Shawinigan to Maisonneuve, a distance of 85 miles. In the sub-station at Maisonneuve, a suburb of Montreal, the 30-cycle, three-phase current is stepped down from 44,000 volts to 2,300 volts. The long-distance line between Shawinigan Falls and Maisonneuve is the longest line east of the Rocky Mountains, and it is operated at the high potential of 55,000 volts at the generating end and 44,000 volts at the receiving end. The line is made of aluminum cable consisting of seven strands No. 6 B. & S. gauge. The wires are mounted on porcelain insulators, the distance between wires being 60 inches. The porcelain insulators are supported by locust pins. The wires are arranged in equilateral triangle. Fig. 1 is a picture of the sub-station in which are installed five 1,066-kw frequency changers designed and built by the Bullock Electric Manufacturing Company, of Cincinnati. The incoming line is clearly shown in the background of the picture. The three-phase, high-potential current is reduced by three Westinghouse transformers from 44,000 volts to 2,300 volts. The five groups of frequency changers which are clearly shown in Fig. 2, change the current from 2,300 volts three-phase 30 cycles to 2,300 volts three-phase 60 cycles. As the picture shows, the frequency changers are set in a row with their shafts parallel. The machine on the left is the 30-cycle motor; the machine to the right is the 60-cycle generator; the exciter which is shown on the right-hand side of the set serves as starting motor and also excites the two alternators. The rating of each set is 1,068 kw at 2,300 volts 60 cycles, 100 per cent. power factor, or 800 kw at 75 per cent. power factor. The speed of the frequency changers is 450 revolutions, the motor being

FIG. 2.—FIVE FREQUENCY CHANGERS AT MONTREAL.

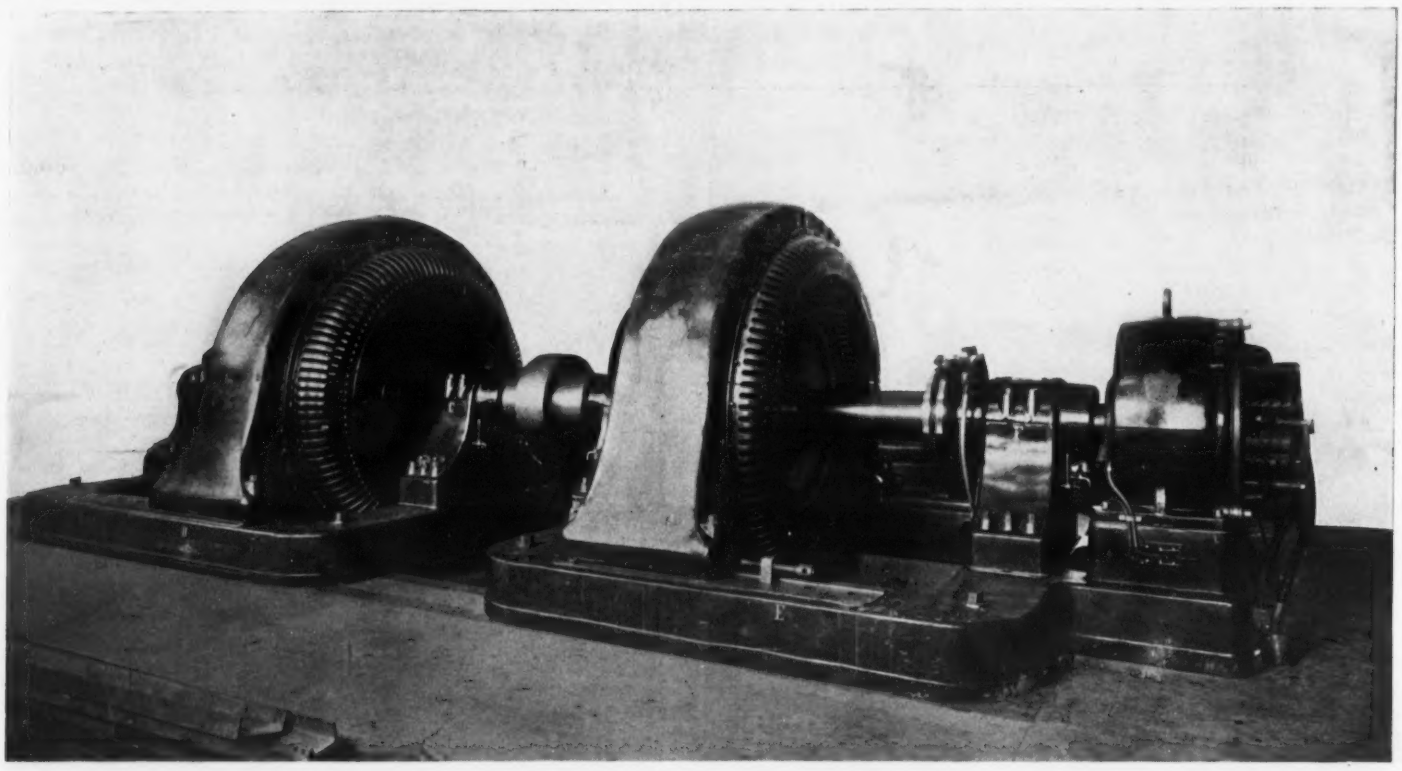


FIG. 3.—ONE OF THE 1065-KW. FREQUENCY-CHANGER UNITS.

an 8-pole machine, the generator a 16-pole machine. Fig. 3 shows one of the sets. The stationary armatures can be moved parallel to the shaft so as to expose the armature and fields for inspection

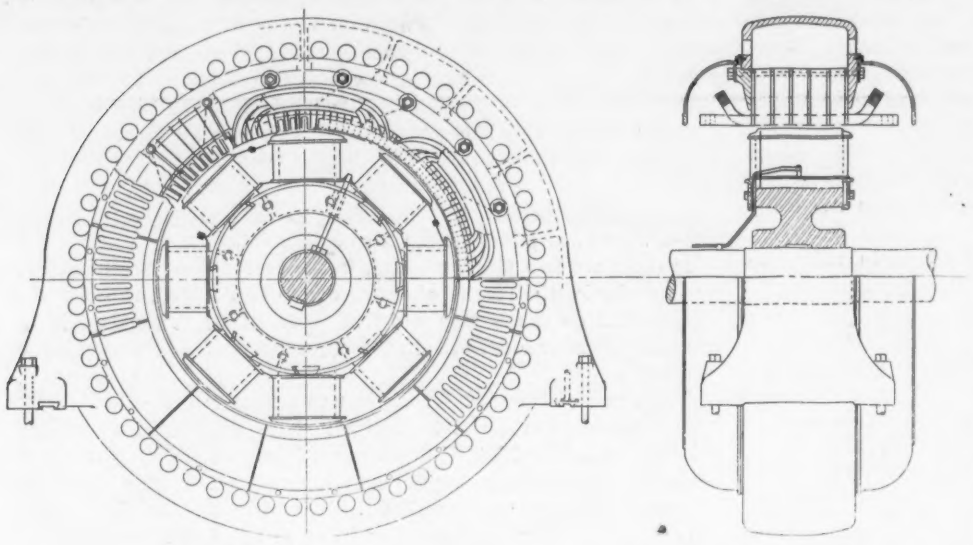


FIG. 5.—1100-KW., 2,300-VOLT, THREE-PHASE, 30-CYCLE SYNCHRONOUS MOTOR.

and repairs. The machines are mounted on I-beams, as shown in Fig. 4, which is an outline drawing of the general arrangement of the machines. Some of the constructional features of the motors and generators are shown in the assembly drawings, Figs. 5 and 6.

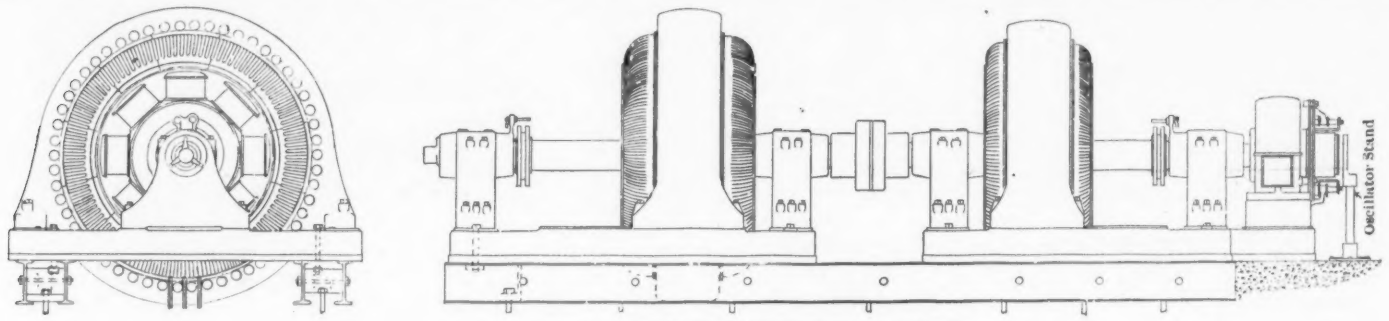



FIG. 4.—OUTLINE OF 1065-KW. FREQUENCY CHANGERS.

On account of the high peripheral speed of 8,000 ft. per minute of the revolving fields, the mechanical construction of the rotating parts has to be made solid and reliable. The rotor spiders are made of cast steel with dove-tailed slots milled into them. The pole pieces are held by means of wedges in these slots. The spider is designed with a central web, which is the best construction for high-speed rotating wheels. These machines were tested at the shops of the Bullock Company at a surface speed of 12,000 ft. per minute.

The high combined efficiency of the sets is shown in the curves represented in Figs. 7 and 8. Fig. 7 shows the combined efficiency for 100 per cent. power factor on both machines for an output of 800 kw at the generator end, while Fig. 8 shows the combined efficiency for an output of 1,066 kw, 100 per cent. power factor on both machines. The combined efficiency includes all the losses of the motor and generator and the bearing friction and windage of the set. At an output of 800 kw at 100 per cent. power factor the combined efficiency of the set is 89.2 per cent., and at an output of 1,065 kw at 100 per cent. power factor the combined efficiency of each set reaches the extraordinarily favorable value of 91 per cent.

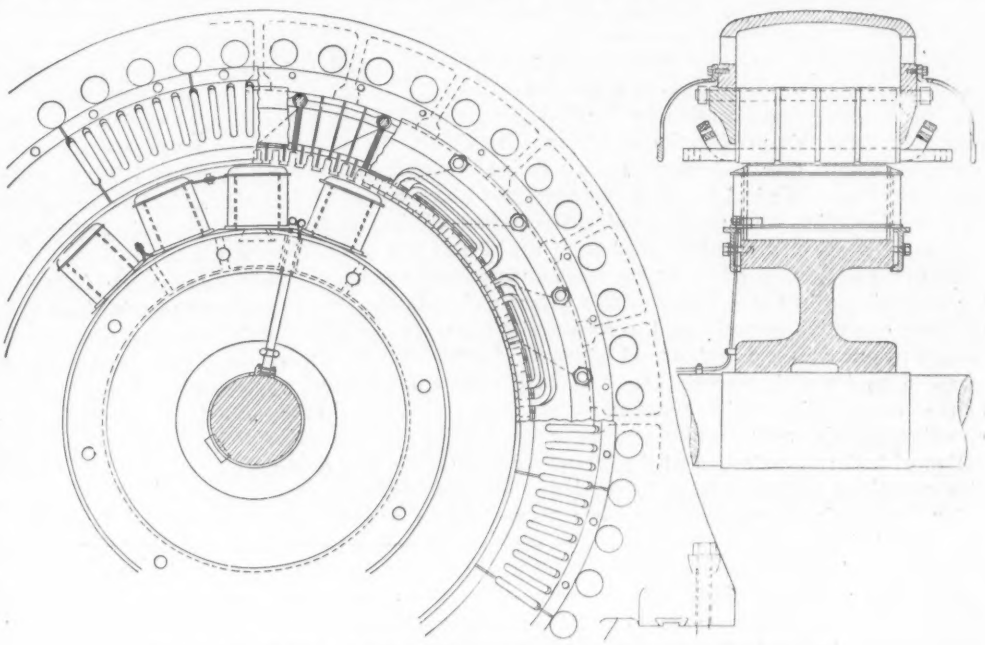


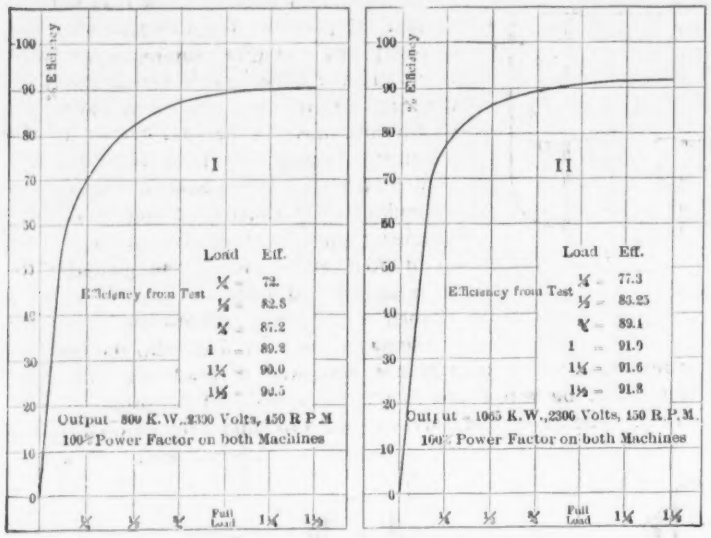
FIG. 6.—1065-KW., 2,300-VOLT, THREE-PHASE, 60-CYCLE GENERATOR.

The frequency changers are started from the exciters. The exciters are good for 75 kw at 120 volts. Although the excitation of each machine does not exceed 18 kw under any conditions of load, it was deemed advisable to use large exciters in order to facilitate the starting of these sets, as at the moment of starting the current taken is quite considerable. A 30-cycle induction motor direct-connected to a 80-kw direct-current generator is used for the starting of the frequency changers.

The operation in multiple of frequency changers is of considerable interest. Imagine a frequency changer to be in operation and a second frequency changed is to be connected in parallel with the first. Imagine that the first set is carrying full load and that the second set is to divide the load with it. The motor can be synchronized in the usual manner by adjusting the field current so that the potential difference between the bus-bars and the synchronous motor vanishes. If the generator is synchronized in the same way it is not possible to put a load on the machine. If the field current of the generator is diminished or increased the load of the frequency changer remains unaltered and the effect of changing the excitation results only in an increase of the cross currents between the two sets. Now then, in order to make the second frequency changer divide the load with the first, it becomes essential to abandon the usual way of paralleling. The following reasoning will at once give us a solution of the problem. Let us assume that both sets are in operation and are dividing the load equally. The saturation curves of the machines being the same, it is clear that the exciting currents of the machines must also be the same if the load be distributed uniformly between them. As juggling the field currents after the machine has been thrown in parallel has no other effect than to increase the cross currents, it is at once evident that the field currents have to be adjusted properly before the machines are thrown in parallel. Hence, assume the first set in operation with

125 amp. excitation on the fields of the generator. If we wish to throw the second set in parallel with the first set, we first synchronize the motor of the second set and then make the excitation of the generator of the second set 125 amp. The bus-bar voltage on which the first set is operating is 2,300 volts; the second set has the same excitation and the terminal voltage of its generator is, therefore, greater than the bus-bar voltage on which the machine is to operate. Assume the drop of the machine at this load to be 12 per cent., then the generator of the second set at 125 amp. excitation on its fields will generate 2,580 volts. The switches must be closed between the two machines at these unequal voltages and the two sets will pull each other in parallel with the load distributed equally between them.

The aggregate power of the frequency changers in this sub-




FIGS. 7 AND 8.—CURVES OF COMBINED EFFICIENCY.

station amounts to 11,000 kw, of which, of course, only one-half is utilized on account of the changing from 30 cycles to 60 cycles. The plant has been in operation since February, 1903.

The unique character of this plant operating on a system which Mr. Alton D. Adams has recently called in these columns, "the greatest center of transmitted power," will justify my supplementing Mr. Adams' article. (*) The line between Shawinigan Falls and Montreal was designed by Mr. Ralph D. Mershon, and the substation by Mr. Wallace C. Johnson, chief engineer of the Shawinigan Water & Power plant.

## Doherty Medal Competition.

Mr. Ernest H. Davis, secretary of the National Electric Light Association, has issued the following important notice:

I beg to call your attention to the following extract from Mr. Henry L. Doherty's presidential address at the Cincinnati convention: "We must give underground construction more consideration than heretofore. We had hoped at this meeting to have a text paper on this subject, but were unable to obtain assistance. What we want is a paper so complete and detailed that it will enable any central station man who is forced to put his wires underground to undertake the work simply by the guidance of this paper; and, with the consent of your executive committee, I recommend that we make this a feature of our next convention, and with your further consent I will award a gold medal, properly inscribed, to the contributor offering us the most complete and comprehensive paper on underground construction, for either alternating or direct-current plants, or a combination of both; the selection of the best paper to be made by a suitable committee to be appointed by the incoming president."

Mr. Doherty's generous offer of a gold medal was accepted by the Association, with the condition that not less than five papers be contributed, but for certain reasons it was decided to postpone the competition until this year. The competition is now open to all wishing to contribute a paper on "Underground Construction." Papers must be received at the office of the Association not later than April 21. Three copies of each paper are requested.

* Alton D. Adams, "Montreal, The Greatest Centre of Transmitted Power," Dec. 5, Dec. 12, Dec. 19 and Dec. 26, 1903.

## Radioactivity and Radiation.

BY J. B. WHITEHEAD, PH.D.

In an article with the above title which appeared in your issue of January 23, Dr. Louis Bell sounds a general warning against the too hasty interpretation of experiment and consequent construction of theory, and in particular he suggests that the new but generally accepted theory of ionization and its bearing on the phenomena of radioactivity, may perhaps require modification in the light of certain other kindred observations of Blondlot and Sanford. The condemnation of the tendency to jump to conclusions, and of the thirst for sensational deductions will receive general concurrence, but the illustration cited seems hardly a case in point.

If there are two pieces of work in the recent literature of experimental physics the results of which are to be doubted, they are that of Blondlot on the N-rays and that described by F. Sanford in the *Physical Review* of December, 1903, on a so-called new type of radiation.

The name of Blondlot is sufficient to attract attention and respect to any of his work, and his claim to have discovered a new type of "ray" was received with widespread interest. Physicists in all countries immediately began experiments, and further investigations by Blondlot were awaited with impatience. As time passed, however, and other experimenters failed in attempts to repeat Blondlot's observations, an element of doubt arose throwing a haze of uncertainty over the whole work. There need only be mentioned among the many questioning the existence of the N-rays, the names of Rubens, Wood and Lummer. In fact, the last-named has shown that many of Blondlot's observations can be explained as being largely due to physiological causes. These observations were frequently on the variation of the intensity of illumination of bits of paper, metal, or of a spark in a dark room. Now, it is common knowledge that if one looks steadily at a star on a dark night, by shifting the eye a little to one side the star appears to change in intensity. Lummer has shown that variations such as those observed by Blondlot may be largely due to such subjective causes, and he points out that a measuring instrument other than the eye must be used before observations of precision can be had. Those of Blondlot's results which are most conclusive and least subject to Lummer's criticism are the ones referring to the condensation of the rays to foci by lenses, thus giving a means of determining their wave length. Apparently, however, all attempts to repeat the original observations have failed, so that until new evidence appears we must reserve judgment here also. Prof. Wood, of Johns Hopkins University, has attempted to repeat many of Blondlot's experiments without success.

From the account in the *Physical Review,* the work of Sanford appears so crude, so wanting in description and data, and so subject to criticism generally that it is difficult to understand how it can be accepted in evidence of anything new. There is hardly an observation which he describes that cannot be explained by the ordinary phenomena of ionization and Röntgen rays, primary or secondary. The observations on reflection and polarization require repetition and fuller description, before they can attract serious attention. The secondary Röntgen radiation which would seem to account for some of Sanford's observations were observed by Perrin in 1897, and their properties have been investigated by Sagnac, Townsend, Thomson and others.

From these facts it seems hardly possible as yet that we have failed to take into sufficient account these new types of radiation in the rapid development of our theories of ionization and radioactivity; theories, the basis of which rest on experiments as conclusive and reliable as they are beautiful.

## "Good in Everything."

A special cable dispatch from Paris of January 30 to a New York daily paper says: "A French scientist, with the English sounding cognomen of Griffiths, has discovered evidence of radioactivity in the petals of several odoriferous flowers. When geraniums and sunflowers are placed near selenium with which an electric current has been interrupted the metal at once displays signs of strange activity and becomes an electric conductor. Dr. Blondlot this week explained to the Academy of Medicine of Paris the peculiar properties of these rays.

## Application of Graphics to Power House Location.

By Sidney Diamant.

IN locating the electrical centroid of an area, over which concentrated loads exist the relative position of which is known, the method described by Dr. Bell has been generally employed. The scheme described in this article occurred to the writer in his desire to develop a method which would eliminate the possible confusion resulting from working directly on the area under consideration.

Given the position and the intensity of the loads, either absolute or relative, the problem is to locate the electrical centroid. As shown in the diagram, the position of a number of loads is located and their relative intensities are represented by the numbers 1, 3, 4 and 6, for example. Draw two axces, *O X* and *O Y*, at right angles with each other. (It has been observed by actual trial that the axces may make any angle with each other and that these axces may pass among the loads if it be more convenient for plotting because of limited space). Project these loads on the axces and continue, for a short length, the lines from these projections perpendicular to the axces. It is then desired to locate the position of two lines or neutral axces on which lies the centroid. The simultaneous position of the centroid on these two axces is at their intersection and locates the true centroid of the various loads.

To locate the neutral axis which is perpendicular to *O Y*, draw a line, *a-e*, parallel to the lines of action of the horizontal load components and on this line lay off successively to scale the different load values, *a-b*, *b-c*, *c-d* and *d-c*, following in the same direction. From the center of this line draw *s'-s* perpendicular to *a-e* and make *s'-s* equal to *a-s'* to conveniently limit the extent of the layout. Draw from the point *s* the component forces, *s-a*, *s-b*, *s-c*, *etc.* This merely enables a combination of the forces in such a way as to effect a neutralization of a component of one load by a component of another. The forces are decomposed as follows:

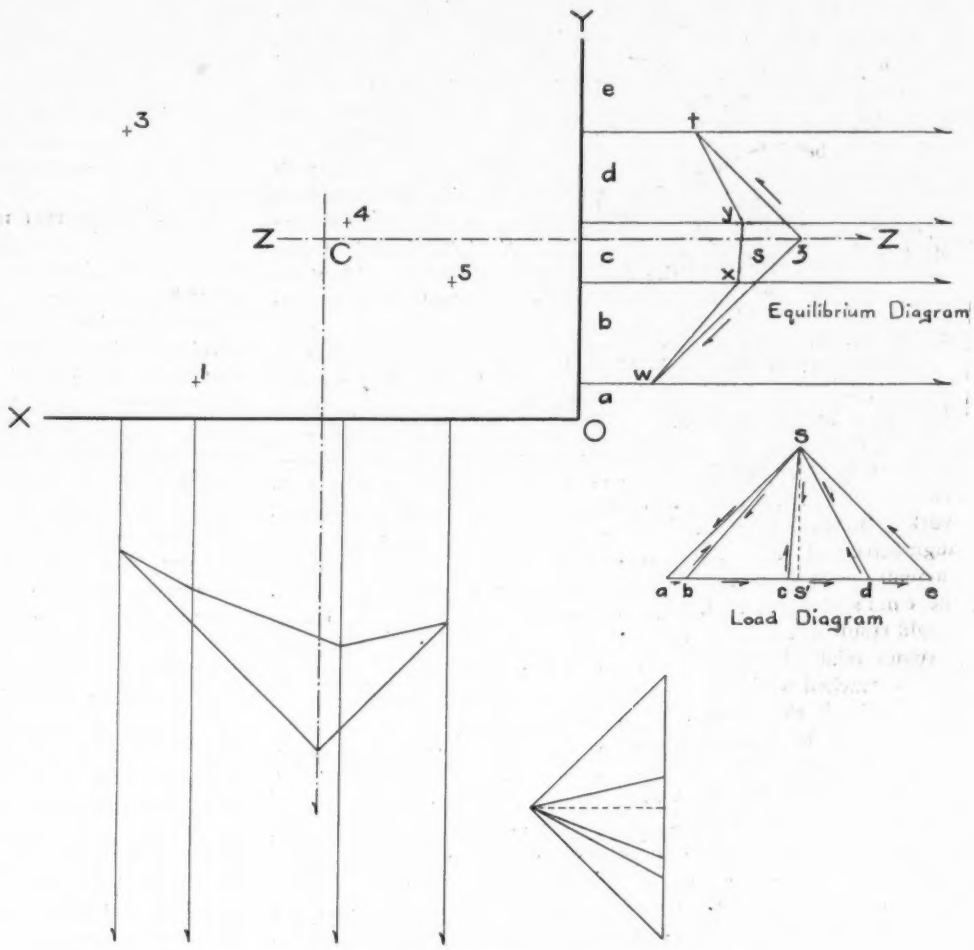
| FORCES. | COMPONENTS. Load diagram. | Equilibrium or directional diagram. |
|---|---|---|
| (*a-b*) ..... | { *b-s* } ..... { *s-a* } | { *w-x* } { *z-w* } |
| (*b-c*) ..... | { *c-s* } ..... { *s-b* } | { *x-y* } { *x-w* } |
| (*c-d*) ..... | { *d-s* } ..... { *s-c* } | { *y-t* } { *y-x* } |
| (*d-e*) ..... | { *e-s* } ..... { *s-d* } | { *z-t* } { *t-y* } |

The letters denote the direction and path of the components; as *a-b* denotes direction from *a* to *b* and along the path *a-b*. Since the forces *a-b* and *b-c* have a common component, *b-s* and *s-b*, along the same path, but in opposite directions, *b-s* component of *a-b* neutralizes *s-b* component of *b-c*. Likewise, *c-s* component of *b-c* neutralizes *s-c* component of *c-d*; *d-s* component of *c-d* neutralizes *s-d* component of *d-e*, so that these components are of opposite sign in the equation of forces and components. Therefore, the sum of the loads, *a-b*, *b-c*, *c-d* and *d-e* is held in equilibrium by the sum of the force components, *s-a* and *e-s*, since the equal and opposite components cancel each other. Thus the total load has *s-a* and *e-s* as load components.

Next, as to the construction of equilibrium diagram: In naming the forces the graphic notation usually employed will be made use of so that a line which separates spaces *a* and *b* indicates the direction of a force, *a-b*. From a convenient point, *w*, on the force directional line, *a-b*, which is a continuation of a line connecting the actual position of the load and its projection on the *O Y* axis, draw the indefinite line, *w-x* (the subscript letter is not shown in the sketch, but is the indefinite end of the line on which is the letter itself, without the subscript, ocupying a definite position) parallel to the force component, *b-s*, of the load diagram. The point, *x*, is at the intersection of the indefinite line, *w-x<sub>i</sub>* with the next force directional line, *b-c*.

Then from *x* draw the indefinite line, *x-y<sub>i</sub>* parallel to the force component, *c-s*, of the load diagram and the intersection of this line with the next force directional line, *c-d*, determines the point, *y*. From *y* draw the indefinite line, *y-t<sub>i</sub>* parallel to the force component, *d-s*, of the load diagram. Then the intersection of this line with the next force directional line, *d-e*, gives the point, *t*. From *w* and *t* draw the indefinite lines, *w-z<sub>i</sub>* and *w-t<sub>i</sub>* respectively, parallel to the load components, *s-a* and *e-s*. Then *z*, the intersection of these two lines, is the point through which passes the resultant of the force components perpendicular to the *O Y* axis.

Because all the load components perpendicular to the *O Y* axis act in directions parallel to one another, the resultant, *Z-Z*, acts in a line parallel to the lines of action of the load components. Since the centroid is the point through which passes the resultant of all the loads, the centroid of the loads is on a line, *Z-Z*, perpendicular to the *O Y* axis on which the loads are projected. If about this line moments be considered due to the loads acting about their respective lever arms, the algebraic sum of the moments will equal zero. Likewise, a similar demonstration will be true of the projected positions of the loads on the *O X* axis, and the position of a second line, on which is the centroid of all the loads, may be determined. The intersection of these two neutral axes indicates the definite position of the centroid of all the loads in their true positions. If, now, any line be drawn through *C*, the sum of all the products of all the loads on one side of this line multiplied by their respective lever arms equals the sum of the products of all the loads on the other side of the line multiplied by their respective lever arms.




APPLICATION OF GRAPHICS TO POWER HOUSE LOCATION.

The result obtained by this method agrees with that obtained analytically by the following equations:

$$L_x = \frac{A\,1_{ax} + B\,1_{bx} + C\,1_{cx} + D\,1_{dx}}{A + B + C + D}$$

$$L_y = \frac{A\,1_{ay} + B\,1_{by} + C\,1_{cy} + D\,1_{dy}}{A + B + C + D}$$

wherein $L_x$ = abscissa of centroid and $L_y$ ordinate of centroid, with

respect to the selected pair of axes. *A, B, C* and *D* are the respective loads and $l_{ax}$ = distance of load *A* from *Y* axis, $l_{ay}$ = distance of load *A* from *X* axis.

A power house or a general distributing center located at the centroid will result in the most economic condition of distribution.

## British Lamme Single-Phase Railway Motor Patent.

The current issue of the London *Electrician* contains a reprint of the specifications of a British patent granted to B. G. Lamme on "Improvements in Electric Motors," which contains a lengthy discussion of the principles of the railway motor associated with the inventor's name. Owing to the interest of this discussion we reprint in full the specifications, including the drawings.

My invention relates to electric motors, and has for its object to construct an improved series-wound motor for use with single-phase alternating currents. Hitherto alternating currents have been applied to operate series-wound motors, but considerable difficulties have arisen in the form of undue heating, excessive sparking of the brushes and low efficiency, together with want of due regulation. According to my invention, I overcome these defects, not by merely modifying the arrangement of parts of the ordinary series-wound motor, but by providing that certain definite proportions and relations shall subsist between such parts, together with various novel features in the construction of the motor. Since the self-induction of the field magnets and the counter e.m.f. set up by the armature are both dependent on the strength of field, a relation subsists between them which is proportional to the speed of rotation of the armature, the relative ampere-turns and the frequency. A higher speed, a low frequency and few turns on the field magnets compared with those on the armature, will give a lower ratio of the field self-induction to the armature counter e.m.f. Both the field strength and the armature magnetic lines of force increase with the current supplied to the motor, and if saturation is not approached each of these will increase directly as the current, and, therefore, the torque which is produced by them jointly will increase as the square of the current, which would be a highly advantageous condition for electric traction work. Increase in strength of field, however, is accompanied by augmented self-induction which, when working with alternating currents, must be reckoned with. Inasmuch as the resultant of all the e.m.f's is equal to the applied e.m.f., increase in self-induction would result in a fall of speed, and if the self-induction of the motor becomes relatively high, the speed will fall very rapidly, and zero will be reached when the self-induction is equal to the applied e.m.f. Conversely, if the strength of the field is kept constant its self-induction will be constant, and, consequently, the armature speed will not fall unless its own induction be very high.

In the two cases above stated the first is that in which the strength of field is approximately proportional to the strength of the current, and in the second case the field magnetic strength is constant. As previously pointed out, the first case provides favorable conditions for electric traction; but it is limited by the fact that the maximum torque which can be developed may be insufficient for maximum requirements. In the second case the torque is not so limited, but on the other hand the general characteristics of the motor may not be suited to given conditions of working. It is, therefore, advantageous to so proportion the motor as to combine the two cases and thus secure conditions through a certain range of working, in which the field strength is approximately proportional to the current, and have the motor capable of developing the required torque. It has been pointed out that the limitation in the torque developed when the field magnetic strength increases in proportion to the current, is due to the rapidly-increasing self-induction of the field as the current is increased, so that the self-induction soon becomes nearly equal to the applied e.m.f. It is desirable, therefore, to provide means for limiting the self-induction so that it does not normally absorb an undue proportion of the applied e.m.f., and when a heavy torque is required, the self-induction of the field shall not limit the current, but shall permit a sufficient current to flow to produce the required torque. As the cross-induction of the armature through the poles acts with the self-induction of the field in limiting the flow of current, it is desirable that this should also be kept within proper limits. It follows, therefore, that the self-induction of the motor, as a whole, in normal working, should be relatively small with relation to the applied e.m.f., and should also have a limiting value which is less than the applied e.m.f., even when the motor is operating under maximum conditions of torque. The relations between the field self-induction and the armature counter e.m.f. may be expressed as follows: Self-induction of field = alternations × field turns in series × induction per pole × constant. The counter e.m.f. of the armature = revolutions × the number of armature wires × induction per pole × constant. The constants used are dependent upon the characteristics of the supply circuit and upon the units in which the different terms are expressed; their values are determined in any given case, according to well-established laws, and the armature winding is assumed to be of the usual parallel type.

$$\frac{\textit{Field self-induction}}{\textit{Armature c.e.m.f.}} =$$

$$\frac{\textit{Line alternations} \times \textit{field turns in series} \times \textit{induction per pole}}{\textit{Revolutions} \times \textit{amature wires} \times \textit{induction per pole}} \times \textit{const.}$$

since armature wires = 2 × poles × armature-turns in series,

$$\frac{\textit{Field self-induction}}{\textit{Armature c.e.m.f.}} =$$

$$\frac{\textit{Line alternations}}{\textit{Poles} \times \textit{revolutions}} \times \frac{\textit{field ampere-turns}}{\textit{armature ampere-turns.}} \times \frac{\textit{constant}}{2}.$$

In a direct-current motor the armature alternations are equal to the product of the revolutions multiplied by the number of poles, and, since this relation may be assumed to obtain in a series alternating-current motor the foregoing formula may be further simplified by substituting the term "armature alternations" for the term "poles × revolutions." It has been pointed out that the self-induction of the motor should be relatively low as compared with the applied e.m.f., since the resultant of the self-induction of the motor and the counter e.m.f. is approximately equal to the applied e.m.f., and it follows that the self-induction should be low in proportion to the counter e.m.f. of the armature in normal working. The relation between the two is expressed in the foregoing formula, and it is now apparent what relations must hold between the elements of the motor itself and between the motor and the external conditions.

In order that the ratio between the field self-induction and the counter e.m.f. of the armature may be low, it is clear that there must be a small number of line alternations, a large number of poles and a high speed, and a small number of field ampere-turns and a relatively large number of armature ampere-turns. The absolute values and the ratios between these several elements which are admissible and suitable for practical design and operation will now be considered. The ratio of field ampere-turns to the armature ampere-turns has, generally, a minimum value which is fixed by the proper operation of the motor itself. If the field ampere-turns are too small as compared with the armature ampere-turns, the magnetic field will be distorted and good commutation will be difficult. The minimum ratio of field ampere-turns to armature ampere-turns is dependent upon many factors in the design, but, in general, it may be said that this ratio should be greater than 0.5 and may sometimes be as high as 0.75.

Therefore, when definite limits have been assigned to two of the ratios in the last equation—namely, the ratio of field self-induction to armature counter e.m.f., and the ratio of field ampere-turns to armature ampere-turns then there is also a definite limit fixed for the remaining term in the equation, i. e., a definite relation between the alternations in the supply circuit, the number of poles of the motor, and its rate of revolution, or, in other words, between the line alternations and the armature alternations. It may be noted that an average working value for the last-mentioned ratio is approximately 0.625, and it has been found that the expression $\frac{\textit{constant}}{2}$ in the foregoing formula closely approximates the reciprocal of 0.625, i. e., 1.6. It follows, therefore, that the last two ratios of the formula cancel out, leaving only the ratios of field self-induction to armature counter e.m.f. and line alternations to armature alterna-

tions, for which definite limits are fixed, as hereinbefore pointed out. With a given number of revolutions, the number of poles must be directly proportional to the alternations in the supply circuit. Thus, for instance, if an eight-pole, 700-revolution motor of a certain capacity is required for 2,000 alternations per minute, 3,000 alternations per minute will require a 12-pole motor at 700 r.p.m.

The foregoing considerations indicate the conditions required for securing a relatively low self-induction of the field of the motor. It has been stated that a limiting value of the self-induction of the motor can be secured by suitably proportioning certain parts of the motor. A method of doing this will now be described. The field self-induction and the armature self-induction may both be limited by special construction of the pole pieces. For instance, slots or holes may be cut in the body of each of the field pole pieces from end to end transversely to the direction of rotation, the amount of iron left at the back of the slots being that which is required for the desired induction. The teeth or narrow portions between the slots or holes are of such cross-section that the desired induction through them may be obtained. The slots or holes may be closed, or nearly closed, at the pole faces, and usually this is preferred, as open slots increase the magnetizing power required in the field winding which, in turn, necessitates more field turns, and results in greater field self-induction. The cross-section of iron in the poles is preferably such that but little magnetizing power is absorbed in addition to that required for the air-gap until the current exceeds the normal rated amperes of the motor. Beyond this normal current the teeth between the pole slots rapidly approach saturation. In order to secure this result, the parts in which the cross-section of the magnetic circuit is reduced should be of comparatively short length, but should, of course, he worked at a high induction. It is not necessary or desirable to subject the whole yoke to a high induction, as the desired results can be obtained by having a short length of small cross-section; whereas, if the whole yoke be subjected to a high induction, the losses due to reversals in the core will be objectionably large, and also the magnetic leakage into the surrounding frame and through the field windings will be objectionable.

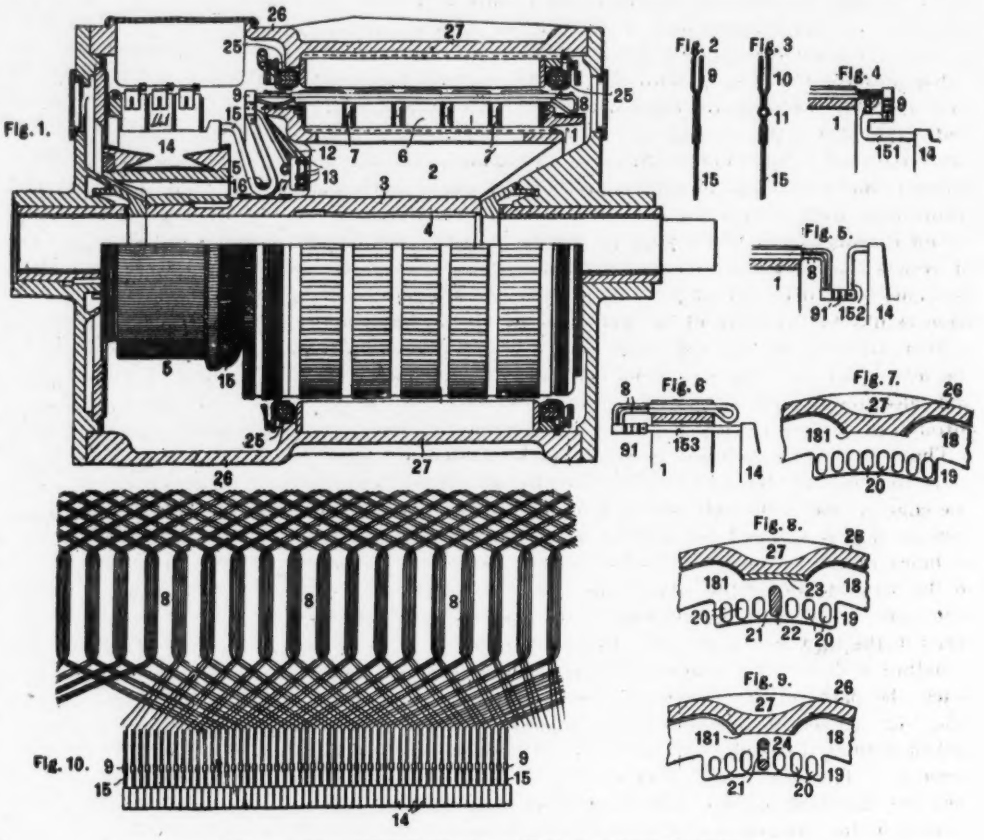
The self-induction of the armature which results from a cross-induction through the poles, in which the magnetic lines enter at one edge or side of the pole and pass through the core to the opposite edge or side, is also reduced and limited by the arrangement of slots or holes which has been described and which would not be obtained in the same degree if the whole yoke were saturated, provided the field cores in the two cases required the same number of ampere-turns in the field for magnetizing them. The cross-induction of the armature is due to the magnetic flux which passes through the field poles, the path for any given pole being through the teeth at one side, then across the slots and also across the pole back of the slots and then along the teeth at the other side of the pole and back to the armature. The smaller the section of the teeth and the more highly they are saturated, the less will be the cross-induction with a given current in the armature. As it is desired to have the induction in these teeth quite high, it is, as above pointed out, desirable to have the teeth as small as possible, and, therefore, the magnetic reluctance of the field circuit is concentrated near the pole face instead of being distributed through the whole yoke. The total useful flux through the armature and field sets up no effective e.m.f. of self-induction in the armature windings, as it will add to the counter e.m.f. at one part and subtract at another part of such winding. But the e.m.f. set up by the cross-induction does not neutralize itself in the same way, and thus becomes an e.m.f. of the same character as that set up in the field windings. The cross-flux from the armature may be further limited by the suitable interposition of a secondary circuit, if desired. For example, if a slot at the middle of the pole contain a conducting plate or closed coil, it will oppose the magnetic flow which would tend to cross the slot. If the ends of a conductor placed through the middle slot be connected with the outer frame of the machine at each end, or if the conductor be closed around the outside of the yoke, then the secondary circuit thus formed will oppose the flow of the cross-induction which tends to pass through the section of iron back of the slots.

The armature winding of the motor is of the closed coil type and is closed upon itself before being connected to the commutator, relatively high resistance leads being inserted between the winding and the respective commutator bars. As the magnetic field of the motor is alternating, any short-circuited turn through which the magnetic flux from a field pole passes will have a secondary current set up in it. By the well-known laws of the transformer the ampere-turns in such short-circuited secondary will approximate the ampere-turns in the primary winding, which is, in this case, the field magnet winding. Certain coils of the armature winding are short-circuited through the brushes when the adjacent commutator bars to which the ends of the coils are connected are bridged by the brushes, and when the latter are located in neutral positions or without lead, the short-circuited turns surround the paths of the magnetic flux and are, therefore, good secondary circuits in which relatively large secondary currents are set up by induction. This is the principal cause of the excessive sparking in series motors of ordinary construction, when it is attempted to operate them upon an alternating-current circuit. In order to obviate destructive sparking, the current in the short-circuited turns of the armature coil should be limited to an amount materially less than what would normally flow. I have found that by inserting a definite amount of resistance in each of the leads between the closed winding and the commutator bars, it is possible to so limit the secondary current due to the alternating field flux as to prevent injurious sparking. The working currents in the armature winding will not pass through these resistances except at the bars in contact with the brushes, because the armature winding is closed on itself inside or beyond the resistance leads. Consequently, the loss in the winding due to the introduction of the resistance can be relatively small, and when the armature is rotating this loss is distributed successively through all the resistances, thus making the average loss per resistance lead very small. Various ways of introducing such a resistance will be described in connection with the accompanying drawings.

With a given current in the motor, the turn of each armature coil which is short-circuited by a brush will tend to have the same e.m.f. set up in it irrespective of the e.m.f. applied to the motor. Therefore, the resistance in the leads may be such that the short-circuited current developed will be limited in amount, and, generally speaking, with full-load current in the motor; the resistance should be such that the short-circuited current will not exceed, say, twice the value of the full-load current. The resistance in each short-circuit will include the resistance of the turn itself plus the resistance of two of the leads, plus also the resistance of the brush holders and brushes. As will appear from what has already been stated, the conditions for suitably low self-induction and for a proper ratio of field ampere-turns to armature ampere-turns practically determine the number of poles the motor should have with a given rate of alternation and speed. This motor will require a relatively larger number of poles as compared with direct-current motors of corresponding size. Moreover, the conditions of good commutation are that the armature circuits of the motor be connected in parallel, and that the number of turns between consecutive armature bars be small. It follows, therefore, that the voltage of the motor is definitely limited, and it is found that the actual voltage is low relative to that for which direct-current motors may be wound—such, for example, as motors employed in ordinary electric traction. While this characteristic would be a serious limitation in connection with the distribution of energy for direct-current traction motors, it is of minor consequence in connection with alternating-current motors, since transformers may be interposed between the supply circuit and the motors, which may be designed to receive practically any voltage from the line and to deliver any desired voltage to the motors. In service, a motor may require either a constant voltage or a variable voltage. For variable speed work the variable voltage is usually desired. A variable voltage may be obtained by the introduction of resistance or self-induction into the circuit or, preferably, by means of a transformer in which the rate of transformation is suitably changed. The several elements which are involved are the motor, the controller, the supply circuit and the transformer. The motor, as has been pointed out, has inherent limitations as to the voltage for which it can be wound, which are independent of the transformers, the controller and the voltage of the supply circuit. The current and the voltage which can be most advantageously handled by the controller may be entirely different from those of the motor. For example, it may be advantageous to design the controller for one-third of the current and three times the voltage which are required by the motor. The line voltage may, in turn, be entirely too high to be introduced directly into the controller or the motor. It follows, therefore, that the voltage of the motor, the voltage of the controller and the voltage of the supply circuit, and their respective currents, which may be most advantageously utilized, may be widely different. It is possible, however, by means

of one or more transformers, to operate a motor adapted to any voltage by a controller adapted to any voltage from a supply circuit of any voltage. A convenient method of control consists in connecting a main transformer across the supply circuit, its secondary being included with the motor circuit but having included in series the secondary of a series transformer, the primary of which derives current either directly or indirectly from the main circuit and is capable of adding to or subtracting from the e.m.f. developed in the secondary of the main transformer.

This invention is applicable in cases where frequent starting is required, as, for instance, in electric traction systems. It is now the common practice in operating electric cars to have two or more electric motors upon each car, and for the purpose of securing varying speeds means are usually employed for connecting the motors either in series or in parallel, and for introducing more or less ohmic resistance into the circuits of the motors. With single-phase motors constructed according to my invention, it is possible to dispense with practically all ohmic resistances for regulating purposes, and it is not necessary to connect the motors successively in series and in parallel for the purposes of regulation, but the motors may be permanently connected either in parallel or in series and all the benefits of the usual series parallel control, as employed with direct-current motors, may be obtained by varying the e.m.f. applied to the alternating-current motors. In some instances it may be desired to connect the motors permanently in series—for instance, in cases where the reduced current will be more suitable for the controllers, or where the increased voltage presents advantages such as would be secured if this voltage were equal to that of the supply circuit. The method of control by means of variable ratio of transformation in the transformer is one which provides a very much higher degree of economy in starting and at lower speeds than is obtained in the usual method of operating direct-current motors where the voltage is reduced by means of rheostats, either with or without the series parallel method of control. In electric traction work, in which starting is frequent, a very large per cent. of the power delivered to the car may be lost in rheostats, thus greatly reducing the efficiency and increasing the cost of operation. It is to be understood, however, that the rheostatic method of control may be used with the form of alternating-current motors herein described, if desired, but usually the advantages of operating by means of transformers with variable e.m.f. ratio without rheostats are very great. The voltage delivered by the transformers is that required by the motor, so that there are practically no losses except those inherent in the transformers and motors, both of which are capable of being so designed as to have high efficiency. With this system full load torque or several times full load torque at starting may be developed with a very small amount of energy from the supply circuit. It also follows that with a given torque developed by the motors, the power taken from the circuit is substantially proportional to the speed of the motors, which is not the case with direct-current motors.




FIGS. 1—10.—SINGLE-PHASE RAILWAY MOTOR PATENT.

In the accompanying drawings, Fig. 1 is a view, partially in side elevation and partially in longitudinal section, of a motor constructed in acordance with my invention. Figs. 2 and 3 are detail sectional views of two of the combined resistance leads and connectors between the armature conductors and the commutator segments. Figs. 4, 5 and 6 are detail views illustrating modified arrangements of resistance leads for connecting the armature conductors with the commutator segments. Figs. 7, 8 and 9 are detail views of different forms of field magnet core construction. Fig. 10 is a diagrammatic development of a portion of the armature winding and connections between the same and the commutator segments. As here shown, the armature, 1, comprises a skeleton openwork frame or spider, 2, the hub, 3, of which is in the form of a sleeve mounted upon and suitably keyed to a shaft, 4, this sleeve being extended at one end to receive a commutator cylinder, 5, which is also suitably keyed to it. The core, 6, of the armature is built up in the usual manner of thin plates or laminæ, properly spaced apart at intervals by ventilating spaces, 7, and provided with slots which, in the present case, are 72 in number, in which are mounted the insulated conductors, 8, constituting the coils of the armature winding. These coils or conductors, as shown, are of strap copper, the turns of which are located side by side in the slots, forming three separate coils, which span the core from the first to the ninth slot, and so on around the core. The coils are properly joined together at one end of the armature by means of suitable connectors, 9 and 10, so as to form a closed parallel winding. The connectors, 10, are provided with sockets, 11, in which are fastened the outer ends of suitable connecting wires or strips, 12, the inner ends of which are connected to balancing rings, 13, in a well-known manner.

For the purpose of reducing the secondary currents that are generated by the alternating magnetic field in the coils which are short-circuited at the brushes to substantially non-sparking limits, I join the connectors, 9 and 10, to the several commutator bars, 14, by means of relatively high resistance leads, 15, there being in the present case 216 commutator bars and the same number of leads. As employed by me, these leads are in the form of strips of German silver, and their dimensions are actually determined, in view of the specific resistance of the material, so as to reduce the secondary current, above referred to, to the desired limits, and the form and arrangement of the leads are also such as to be properly accommodated by the space available and so as to be properly ventilated and securely supported independently of each other. The commutator brushes, 141, are arranged in sets in the holders or arms, and, in the present instance, the arms or holders are eight in number. The brushes and arms may be of usual material and construction and connected in the usual manner to properly co-operate with the commutator cylinder and the supply circuit. As indicated in Fig. 1, the leads, 15, are bent into substantially the form of U-shaped loops, the inner ends of which are held in place by means of a suitable winding, 16, an insulating band, 17, being interposed between the leads and the sleeve, 3, of the armature spider. As illustrated in Fig. 4, the resistance leads, 151, are shown as having a substantially U-shaped form, one arm of which extends beyond the other for connection to the commutator bar and the two arms of which are approximately parallel at the armature axis. In Fig. 5 the resistance leads, 152, are shown as having each a main

body position substantially perpendicular to the armature axis and an outer end which extends approximately at right angles to the body portion for connection to the commutator bar. In this case the end of the armature conductors project inwardly, approximately parallel to the body portions of the leads, for connection to the connectors, 91, which are also substantially at right angles to the body portions of the resistance leads. In Fig. 6 the resistance leads, 153, are connected to the ends of the armature conductors, at the end opposite the commutator, and project through the spider to the commutator and, substantially parallel to the axis of the armature. Other forms and arrangements of resistance leads may, perhaps, be devised which will be adapted for the purpose. These, I have shown, are such as I have been able to devise to most satisfactorily provide the necessary resistance and, at the same time, be economically and safely disposed in the available space in the motor.

As has already been pointed out, the number of field magnet poles of the motor must be directly proportional to the rate of current alternation in the supply circuit, and other conditions, which have been heretofore pointed out in detail, render it desirable, and, in fact, necessary, for successful operation that the rate of line alternations shall be low, and that the rate of armature alternations shall be relatively high. The motor here illustrated and described was designed for a frequency of 2,000 line alternations per minute, and the motor which is adapted to this number of alternations and the other conditions has eight field magnet poles. The field magnet core, 18, is in the form of a hollow cylinder and is built up of thin plates or laminæ, the laminated construction being necessary by reason of the fact that the magnetic flux, due to the field magnet winding, is alternating.

The polar projections or pole pieces, 19, are provided with holes or perforations, 20, extending through the same, transversely to the direction of armature rotation, and located in close proximity to the ends of the polar projections or pole pieces, and the depth of the body portion of the core is reduced at the rear of each polar projection, as shown at 181, in Figs. 7, 8 and 9, in order to aid in reducing the cross-magnetization and, consequently, the armature self-induction. The slots, 20, are made comparatively shallow in order to keep the iron loss low and at the same time to insure the desired saturation of the adjacent iron when the current materially exceeds the rated amperes of the motor. These slots may be entirely closed at the pole faces, as indicated in Figs. 7 and 8, or they may have narrow openings, as shown in Fig. 9, but in every case where open slots are employed the openings should be small. As shown in Fig. 7, there are eight of the holes, 20, which, as above stated, are of such dimensions and so spaced as to provide a cross-section of metal between them which will become quickly saturated when the current in the field magnet windings materially exceeds the rated amperes for which the motor is designed. In Fig. 8 are shown six holes, 20, and at approximately the middle of the pole piece is a hole, 21, which is of materially greater depth than the holes, 20. In this hole, 21, is located a bar or plate, 22, of copper or other good conducting material, for the purpose of serving as a closed secondary circuit to reduce the armature self-induction due to the cross-magnetization. In Fig. 8 is shown a plate, 23, of copper or other good conducting material, which also acts as a secondary closed circuit to oppose any cross-magnetizing flux which tends to pass outside of the core, 18, of the field magnet. In Fig. 9 the construction is the same as that shown in Fig. 8, except that a single turn, 24, of wire constituting a closed coil is placed in the middle slot, 21, instead of the bar or plate, 22, and the plate, 23, is omitted. Other forms of conductors suitably disposed to act as secondaries and thus oppose the cross-magnetizing flux might be employed, if desired, those shown being set forth merely as examples that I have found well adapted for the purpose. The field magnet winding, 25, is here shown as comprising eight coils of strap copper, bent edgewise and connected in series and so insulated and supported as to perform the functions desired, and, at the same time, be effectively insulated and occupy a minimum amount of space. In the present case the winding comprises 20 turns, one-half of the coils having three turns and the other half having two turns, and the coils of the two sets are alternately disposed around the core. A greater number of turns may be employed, if desired, provided they are so connected that the number of turns in series does not materially exceed that specified above.

The field magnet core and coils are mounted in a casing, 26, which is provided with extensions at its ends to enclose also the armature and commutator. As shown, this casing projects inwardly, at the backs of the pole pieces, to constitute supports for the core, 18, and is correspondingly hollowed out as regards its exterior, as indicated at 27, so as to lessen the weight of the structure. This form may be varied from what is shown, if desired, and the points of support between the core and the casing may be otherwise located. The casing may also be made of openwork skeleton construction, if desired, since its office is mainly that of a support for the field magnet.

Various methods of controlling motors, constructed in accordance with this invention, may be employed, it being preferable, as above stated, to vary the e.m.f. applied to the motors. For this purpose a transformer may be interposed between the motor and the supply mains, and the e.m.f. of the secondary may be varied by varying the number of windings of the primary or secondary, or varying their magnetic relationship in a manner well known in the art. Either a two-coil transformer or an autotransformer may be employed. Another very convenient means consists in the employment of a three-coil transformer, the third coil of which is connected with the primary coil of a second transformer, the secondary coil of which is in series with the secondary coil of the main transformer, as above described. Rheostats or similar adjusting means may obviously be employed in addition to or instead of the means for varying the voltage. It will be understood, however, that the invention is not limited to the method of control or restricted to any precise method.

The claims of the patent are as follows:

1. A single-phase, alternating-current, series-wound motor, in which the ratio of the field magnet self-induction to the armature counter e.m.f. is approximately equal to the ratio of the line alternations to armature alternations, substantially as described.

2. A single-phase, alternating-current, series-wound motor having a closed-coil, parallel-wound armature with relatively high resistance leads connecting the armature coils with the several commutator bars, and a field magnet the poles of which have slots transverse to the direction of rotation of the armature and with or without a closed conductor inserted in one of the slots and extending through approximately the central portion of the pole, substantially as described.

3. For use with single-phase alternating electric currents, a series-wound motor having the ratio of the number of its field poles to the number of current alternations per minute approximately as 1 to 250, and having a ratio of field ampere-turns to armature ampere-turns approximately as 20 to 27.

4. Electric motors for use with single-phase, alternating currents constructed substantially as described with reference to the accompanying drawings.

## Extensive Train Lighting.

President Mellen, of the New York, New Haven & Hartford Railroad Company, has issued orders to the traffic department to equip a vestibuled train with an electric lighting plant, with generators on the car axles. It is stated to be President Mellen's intention to replace gas with electricity all over the line, and this progressive plan is to be put into operation at once.

## A Manacled Inventor.

A most extraordinary and almost incredible yarn comes to us from New England, about Henry K. Goodwin, alleged to be held in bondage by the machinations of the Bell telephone interests. A bill is up in the legislature which, if passed, would result in the release of Henry K. Goodwin, now in Charlestown State Prison, who was convicted of the murder of Albert D. Swan, of Lawrence, in 1885. In the process of the hearing Senator Callender, of Boston, astonished the committee and the spectators by asking Lawyer Rowley, who represented Goodwin: "Haven't the electrical corporations in this State opposed Goodwin's pardon?" Mr. Rowley replied: "In my opinion the electrical corporations have done everything in their power to prevent the pardon of Goodwin. And there is in existence correspondence which will show it." "Didn't Goodwin invent a switchboard which is substantially the one now in use by the Bell Telephone and New England Telephone Companies?" demanded Senator Callender, and Mr. Rowley answered: "I understand that to be the case." It would be very interesting to know what kind of a board Goodwin invented, if he ever did invent one.

## Discussion on A. I. E. E. Papers on the Single-Phase Railway Motor.

Owing to the great interest of the subject, we supplement our report last week of the January meeting of the American Institute of Electrical Engineers with the discussion in full by Messrs. Lamme, Steinmetz and Armstrong, and the non-mathematical part of the remarks of Prof. A. S. McAllister.

LAMME DISCUSSION.

In the paper presented before the American Institute in September, 1902, I called attention to the fact that there were but two types of single-phase, alternating-current motors having suitable characteristics for railway service, viz.: that called the "series type," and the "repulsion type." Both of these motors have armatures like direct-current motors with commutators and brush holders. Attention was called to the fact that both motors have suitable characteristics for railway service, as both automatically give variable speed characteristics with changes in load. That paper primarily described a single-phase railway system, and the motor formed but an element in the general system. It was a very general opinion at that time that the success of the commutator type of motor for large sizes as doubtful, and the sparking feature was considered a fundamental source of trouble. It was generally conceded that if a motor with series characteristics could be made to operate successfully, it would be a great step in advance in the railway field. Since that time single-phase railway systems have been more fully developed. Practically no departures from the general system then indicated have been furnished, and the types of motors developed have been along the lines of the two motors indicated in that paper.

Up to the present time the only suitable motors suggested for this work have been of the commutator type, and have been those having series characteristics. I have suggested that all these motors can be considered broadly under the one class of series motors, as they all have the series characteristics of the direct-current series motor. I further suggested that they can be subdivided into the "straight series" type and the "transformer series" type. The transformer series could also be arranged in two classes, viz.: one in which the armature or field is supplied by an external transformer, and one in which the transformer is placed in the motor itself; this latter is the repulsion type of motor.

Figs. 1, 2 and 3 illustrate the three classes, Fig. 1 being the straight

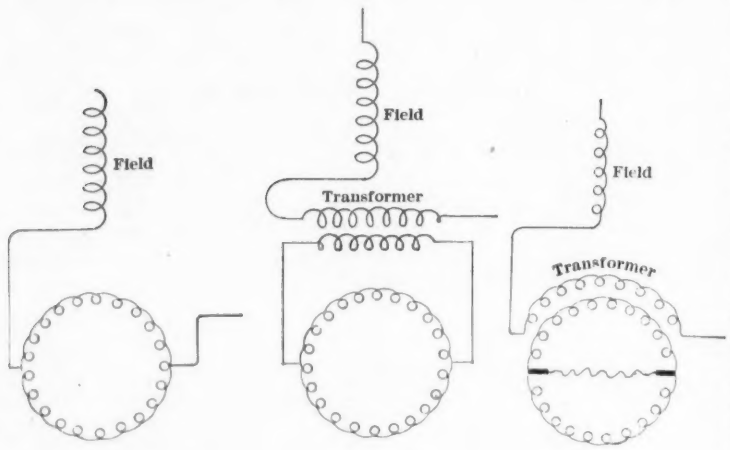



FIG. 1. FIG. 2. FIG. 3.

series, Fig. 2 the transformer series and Fig. 3 the repulsion motor. Fig. 2 would be considered as a true series motor, although the armature and field are not directly in series, and yet most of the characteristics described as belonging in the repulsion motor apply directly to the transformer motor shown in the figure. Comparing the relations of these motors, viz.: the straight series and the repulsion motor, we will first take up the straight series.

In this motor, if properly designed, two voltages can be considered, viz.: that across the field circuit, and that across the armature circuit. The armature voltage can be made practically non-inductive so that the input of the armature will represent practically true energy. The voltage across the field is practically at right angles to the armature voltage, and represents very closely the wattless component supplied by the motor. The resultant of these two voltages will then be the line voltage. The power factor of the motor when running is represented principally by the voltage across the armature winding being increased slightly by the losses in the field core and winding. Therefore, for high power factors it is important that the voltage across the armature circuit be made as high as possible, relative to the applied voltage, and that across the field as low as possible.

There are three ways in which to increase the voltage across the armature, viz.: by increase in speed, by increase in the number of wires in series in the armature, and increase in induction through the armature. By increase in speed and increase of the wires in series, the armature voltage will be increased without affecting the field voltage, and therefore the ratio of the armature voltage to the line voltage is increased. Increasing the induction in the armature also increases the induction in the magnetizing coil in the field, and the voltages of both are increased. Therefore, this increase does not improve the power factor of the machine.

Instead of increasing the armature voltage, the voltage across the field winding may be decreased for improving the power factor. This can be decreased in two ways, viz.: by reducing the turns in the field coil or by reducing induction through the coil. Reducing the induction through the field reduces the induction in the armature winding also, and therefore represents no gain; and, therefore, reduction in field turns is the feasible means of reducing the field voltage. Reduction in field turns can be accomplished in two ways, viz.: by decreasing the effective length of air-gap in the motor, and by increasing the cross-section of gap. By making the gap very small the voltage across the field could be made very small compared with the line voltage, and extremely high power factors could be obtained, whether the motor is of the straight series or repulsion type. Also by increasing the section of the air-gap the turns of the field can be decreased with a given total induction through the coil, and the power factor can thus be very considerably increased. The first method, viz.: decrease in gap, is limited by practical conditions, which have been determined from long experience with direct-current work. It should be borne in mind when published descriptions of such motors are given that the results, as regards power factor, generally depend upon data which is not given in the description, such as the magnetic dimensions of the armature and field, the length of gap, etc. Therefore, a machine may be described as showing an extremely high power factor, which may in practice not be a commercial machine, from the standpoint of American railway experience. Increasing the section of air-gap without decreasing the length of gap also improves the power factor, but makes a larger and heavier machine, as a rule.

Both these modifications reduce the ampere-turns in the field. The direction of the improvement in the armature was shown to be in increased armature ampere-turns with a given speed. It therefore follows that almost any result desired can be obtained as regards power factor by increasing the armature ampere-turns and decreasing the field, or exciting ampere-turns. I will refer to this point in considering the repulsion motor.

It should be noted that in all these motors there should be but little saturation in the magnetic circuit, and but few ampere-turns expended in saturation of the iron under normal conditions. This consequent low saturation in such motors leads to certain characteristics in the torque curves which have been cited this evening, as an indication of superiority of the alternating-current motors over direct-current motors, namely, a torque increasing approximately as the square of the current. In fact, this superiority of torque should be charged to the non-saturated condition of the motor rather than the alternating-current principle. If direct-current motors were worked normally at as low induction as the alternating-current motor, then the direct-current motor would show better torque characteristics, which would be comparable with the alternating motor. This claim for a better torque in the alternating motor compared with the direct seems to be a case of making a virtue of a necessity.

It is evident from what has been said that the power factor of the straight series motor can be made anything desired, it being a question of proportion between armature and field, length of air-gap, amount of material used, etc. In practice a compromise would naturally be made among the various characteristics, and a slight reduction in power factor is probably of less importance than a corresponding reduction in size and weight. Also large clearance is probably of more importance than an extremely high power factor at normal load. In practice it will be found that such motors are made with armatures with a large number of ampere-turns compared with the fields in order to obtain comparatively high power factors with large

air-gaps. The number of poles need not be made such that the produce of the poles by the normal speed represents the frequency of the supply circuit. Good series motors can be made, and have been made, in which the number of poles were very much larger or much smaller than represented by this relation.

Taking up next the transformer type of motors, Fig. 2 represents one type of these. In this the field is in series with the primary of the transformer, the secondary of which is connected to the terminals of the motor. I would call this a true series motor, although it is not a straight series motor. In this motor the voltage across the armature can be made practically non-inductive and the voltage across the primary of the transformer will be practically non-inductive. The voltage across the field winding will have practically 90° phase relation to that across the primary of the transformer, and the magnetic field set up by the field winding will have a 90° relation in time, to the magnetic field in the transformer, as in the repulsion motor. In this motor the voltage across the transformer will be highest at light loads and will decrease with load until zero speed is reached. At start there is lowest induction in the transformer and highest induction in the field winding. Such a motor will have speed torque characteristics very similar to those of a straight series motor, except as affected by the actions taking place in the transformer itself. If the transformer possesses no reactance, then at start the current in the armature should be the same as if connected as straight series motor, and the conditions of torque at start should be the same. If the transformer possesses reactance, then at start the current in the armature will not be quite equal to the current which the armature will receive if coupled as a straight series motor, assuming the transformer to have a 1 to 1 ratio. Neither will the armature current be exactly in phase with the field current; therefore, the starting torque of a motor connected in this way will be slightly less than the torque of the same motor if connected in straight series. This is on the assumption that the transformer is one proportioned for small reactance; but if the primary and secondary windings of the transformer should be on separate cores with air-gap between, then the reactances of the windings are considerably greater than in the above case. Therefore, we should expect a motor with such a transfer would give still lower torque than the straight series with the same current supplied from the line.

In a repulsion motor the transformer is combined with the motor itself and the primary and secondary windings are upon different cores with an air-gap between. The starting conditions of such a motor as indicated above should be poorer than the straight series motor, or for the same starting torque somewhat greater apparent energy should be required. It stands to reason that applying the current directly to the armature winding should give greater ampere-turns and better phase relations than generating this current in a secondary circuit, and not under ideal transformer conditions. The tests which I have made, as well as the results shown in the curves of the papers given to-night, indicate this. It is to be noted that the torque curve is not the same shape near the zero speed point as the torque curve of the series motor.

Series motors and repulsion motors may be indicated in the simple form shown in Figs. 4 and 5. In the diagrams of the repulsion motor (Fig. 5), two field poles, *F F*, are shown, and two transformer poles, *T T*. To obtain high power factors on such a motor the ampere-

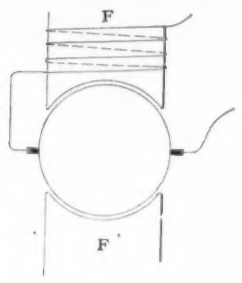



FIG. 4.

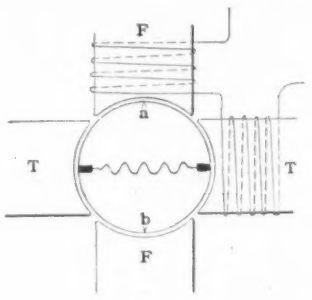



FIG. 5.

turns in *T* must be much greater than in *F*, which means that the ampere-turns in the secondary or armature are much greater than in the exciting field, as in the series motor. The high power factor obtained with these motors is, therefore, due principally to the small ampere-turns in the field and the small voltage across the field.

With brushes set at an angle of 16°, for instance, from the primary or resultant field, the ratio of armature to exciting field turns would be almost 5 to 1, a ratio which will also permit of extremely high power factors in well designed straight series motors over wide ranges of speed. To this feature should be credited the good power factors claimed for the repulsion motor. In either the series or repulsion type of motor, high power factors, especially at low speeds, are directly dependent upon this fact of high ratio of armature to field, and with a high ratio, high power factors should be obtained without crediting the result to leading currents in the armature. In the diagram of the repulsion motor the line current indicated flows through to the field winding and the transformer winding. The primary current sets up a magnetic field in the exciting windings in phase with the line current. If it also set up a field in the transformer in phase with the line current, then the e.m.f. generated in the armature winding due to rotation would have a 90° relation to the e.m.f. set up by the transformer, and a correcting or magnetizing current would flow. This flow is in such direction that it corrects the relation between the two voltages in the armature by shifting the transformer magnetism one-quarter phase later than the exciting field magnetism. This armature corrective current thus may be considered as magnetizing the transformer, making the primary input to the transformer practically non-inductive, but this magnetizing or correcting current may be considered as flowing in a circuit at right angles to the field magnetic circuit, and having practically no effect on the field circuit. Therefore, as a rough approximation, the exciting field may be considered to represent the wattless component of the input, and the transformer field the energy component, as in the series motor.

As to the statement that the magnetizing current in the armature reduces the wattless component of the exciting field, I do not accept it broadly. If this component is reduced, then another component of practically equal value is introduced somewhere else, for the power factors obtained with such motors can be accounted for by the high ampere-turns in the armature winding, compared with the field or exciting ampere-turns. If the armature current improves the power factor by diminishing the magnetizing or exciting field, then the curves in curve sheets 1 and 4 of Mr. Slichter's paper should show it. I have gone over both sets of curves calculating

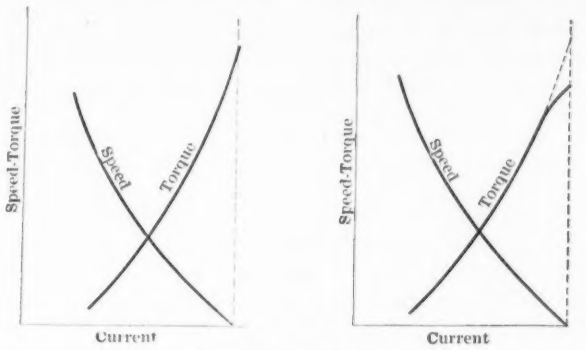



FIG. 6.—SPEED-TORQUE CURVES.

the wattless components from the power factors. From this and other data in these curves I find that beginning near synchronous speed the wattless component in the motor goes up slightly faster than would be represented by the field excitation, assuming it to be entirely wattless. Therefore, according to these curves, the power factor at lower speeds are not quite as good as would be obtained by a field entirely inductive and the armature entirely non-inductive, in a straight series motor. These calculations are rather approximate, as the curves do not check at all well with each other. For instance, the output of the motors is represented by the input multiplied by the power factor and the efficiency. The output is also represented by the product of speed by torque. These two results do not check at all well in either set of curves, there being discrepancies as high as 10 per cent. In curve sheet No. 4, for instance, either the torque or the speed is too high for the lower speeds. Checking back on this curve, using either the speed and torque or the power factor and efficiency for determining the output, I find that the wattless component in the motor at 190 revolutions is approximately 20 per cent. higher than it would be if the field excitation alone were wattless, assuming at 440 revolutions the wattless component is represented purely by field excitation; that is, from 440 to 190 revolutions the wattless component is increased 20 per cent. over that which would be represented by field excitation alone. This indicates that not only should the field excitation be considered as practically watt-

less, but that in addition there is a wattless component due to reactance in the armature widings, etc.

The armature current can be split into two components, one of which is partly magnetizing and represents no torque. The other component is in phase with the field magnetism and, therefore, represents torque. The magnetizing or wattless element may be comparatively small, as the number of turns in the armature is relatively large, but the armature thus carries at times a slightly larger current than the straight series motor.

A further inspection of the diagram (Fig. 5) indicates how the power factor of the motor can be made very high at synchronous speed. At all speeds the voltage generated in the armature due to rotation in the field *F*, is practically equal to the voltage generated by the transformer *T*, thus making zero voltage across the terminals. But also at synchronous speed the voltage generated by the exciting field acting as a transformer, between the points *a b* will be practically equal to the voltage generated in the winding by rotation of the winding in the transformer field. Therefore, across *a b* the voltage is practically zero with these conditions, but the frequency remains the same as that in the field. If now the magnetizing current be supplied across the points *a b*, then the required ampere-turns for magnetizing the motor can be supplied at practically zero voltage, and the turns of the external magnetizing field can be omitted. Therefore, under this condition the wattless component is practically zero and the power factor becomes practically 100 per cent. This is the method of excitation used on certain European single-phase motors in which high power factors are claimed for full-load running. But this method of excitation does not improve conditions at start as the same excitation will be required at standstill, whether the excitation be supplied to the armature or to the field. Therefore, this method of excitation does not help the motor at that condition of load which is the severest on the generating and transmission system. It has the advantage of omitting the field exciting winding, but has the great disadvantage of requiring a double set of brushes on the commutator with but half the distance between the brushes found in the straight series or the ordinary repulsion motor. I do not believe that such methods of compensation are of sufficient advantage to overcome the complications attendant upon them.

At zero speed both the straight series and the repulsion motors will show low power factors and with equal losses in the motors the repulsion should have slightly lower power factor than the series. This question of power factor at start is largely a question of internal losses in the motor at rest, and the repulsion motor in individual cases may show higher than the series motor, because it may be designed with higher internal losses. The real measure of effectiveness is not the power factor at start, but the apparent input or kilovolt amperes at start required for a given starting torque. With equally good designs of motors, my experience is that the kilovolt amperes will be found to be considerably less with the straight series than with the repulsion motor, due to the fact that the current is fed directly into the armature and not by transformer action, and, therefore, the conditions of phase relation and amount of current in the armature winding are more favorable. Therefore, it follows that in order to have the same kilovolt ampere input for the same starting torque, the repulsion motor should have a smaller length of air-gap than the corresponding straight series motor, or should have a greater section of air-gap, which means greater weight of motor. This is one of the conditions which has led me to the advocacy of the series motor rather than the repulsion motor, as I have considered this condition of starting of more importance than running, although I am satisfied that many of the running conditions of a well-designed series motor will be found in practice to be superior to those of an equally well designed repulsion motor.

Referring again to Fig. 5, it will be noted that two fields are set up in such a motor, and that at synchronous speed these two fields are equal. In the straight series motor there is but one field set up, the other being omitted. It is evident that the straight series motor with the current supplied directly to the brushes can have a smaller section in certain parts of the magnetic circuit than is required for the repulsion motor, and that, therefore, the weight of material would be less, and the external dimensions can be less. Therefore, it follows that for equally good designs and same frequency, the straight series motor should be more compact and should weigh less than the repulsion motor. It is reasonable to expect this, as the repulsion motor contains a transformer in addition to the other parts found in the straight series motor. Furthermore, the transformer found in such a motor is one with an air-gap and with the windings on two separate elements, and, therefore, cannot be as well proportioned as a separate transformer could be. Also, there is a transformer for each motor, and in a four-motor railway equipment, for instance, there would be four transformers of smaller size against one larger transformer used with the series motor, this larger transformer having a closed magnetic circuit, and of a highly efficient design compared with the transformers in the motors themselves.

A further point should be taken up in the comparison of these motors, viz.: the current in the coil short-circuited by the brushes. This coil is a secondary to the field and the current in it is necessarily greatest at the period of strongest field. Therefore, this current will be greatest at the time of starting. If the repulsion motor and the straight series motor have the same field strength at start, then the short-circuited current should be the same in each. But as the current is fed into the armature in the repulsion motor through transformer action, it will be found as a rule that the starting field strength of such a motor is slightly greater and the starting armature strength slightly less for a given torque than is found in the straight series motor having same ratio of armature to field windings. Therefore, the short-circuit current at start will be somewhat larger for the repulsion motor than the corresponding staight series motor. This short-circuit current may be somewhat less near full speed than in the straight series motor, but it is not the full speed condition which is the serious one. The short-circuit current at start is one of the most serious conditions which confronts us in alternating-current motors, and is also of great importance where there is any considerable operation on low speeds, and I have advocated a type which I consider gives the easiest condition in this regard. This short-circuiting cannot be entirely

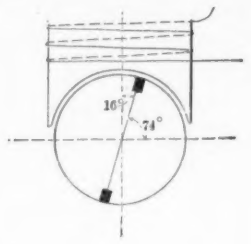



FIG. 7.

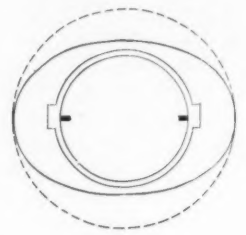


FIG. 8.

avoided in any of the motors brought out without adopting abnormal and questionable constructions, although devices like narrow brushes, sandwich windings, etc., have been proposed. In certain foreign motors the brushes used are so narrow that they cover practically the width of one commutator bar. As such motors are generally built with a very large number of bars, the brushes used are extremely narrow, being approximately 0.2 in. thick at the tip. This will undoubtedly lessen the short-circuiting, but I consider that it is simply transferring trouble to another point, and not avoiding it. A brush 0.2 in. thick is not a practicable one for commercial railway service. At higher speeds, with only a moderately rough commutator, such brushes will be liable to chip and break. I have had experience with ¼-in. brushes on such high-speed commutators and speak from experience. Further, I do not believe that the brush on a street car motor should be so narrow that it bridges but one commutator bar. A brush should bridge at least two bars to give good smooth brush operation. I have made a practice of using ½-in. brushes on motors of say 100 hp.

The sandwich winding, which consists of two or more windings side by side, will prevent short-circuiting at the brushes, but is another case of transferring trouble to another point. It has been found in practice that it is difficult to run a sandwich winding without trouble at the commutator with direct current without a tendency to blackening and pitting of the commutator and I consider that with alternating current this tendency to pitting and burning of the bars would be equally great.

As a rule, I have found little difference between the operation of repulsion and straight series motors as regards sparking, except that the repulsion motors generally have greater current in the short-circuited coil near zero speed, and, therefore, show greater tendency to heat and spark. At or near synchronous speed there appears to be very little difference in the commutation, although I have never-

given the repulsion motor the test of long-continued service that I have given the series motor. The series motors with which I have worked have never shown any tendency to give trouble on the commutator, and on the exhibition car equipped with four 100-hp motors, the commutators have never been sandpapered since the equipment has been put into service. This exhibition car is used principally for showing the accelerating properties of the motors. I have, therefore, no hesitancy in saying that the straight series motor will prove to be equal to the direct-current motor as regards action at the commutator. Wide brushes are used, such as have been used in street railway motors.

It is well known that with large direct-current motors, especially where operated at very high speeds, there is a tendency to flash across the commutator, or to the frame of the motor if the field circuit be opened for a period long enough to allow magnetism to drop to zero, and then the field be closed again. In this case there is a rush of current before the field has had time to build up, and this rush of current, together with field distortion, may cause serious flashing. In the alternating-current motor, whether of the straight series or the repulsion type, this tendency should be entirely absent. In the straight series motor the magnetism falls to zero once in each alternation, and, therefore, if this tendency to flash existed it would occur continually. The lamination of the magnetic structure and the proportions of the machines which permits it to operate successfully on alternating current tend at once to cure this trouble from flashing found in direct-current motors. Furthermore, a properly designed straight series motor can be short-circuited across the brushes without injury to the motor, and can continue to operate in this way. Therefore, if the machine can be short-circuited in this way, there is no tendency to maintain an arc if suddenly short-circuited.

Returning to the subject of power factors, it should be noted that high power factors are very frequently found in motors of low or only mderately good efficiency. This low efficiency, to a slight extent, explains the high power factor in some motors, both polyphase and single-phase. Low efficiency means higher true energy expended, and with a given wattless component it means higher power factor. It is the old problem of increasing the power factor by wasting energy in a circuit instead of reducing the wattless component. The power factor of any alternating motor can be very considerably increased by putting resistance in series with it. Instead of this resistance the internal losses of the motor may be made higher, which will accomplish the same results. The motor will, therefore, appear to have a higher power factor than it really deserves, if efficiency of the motor is taken into account. If, for instance, the efficiency at 300 revolutions shown in Mr. Slichter's curve sheet 4 would be made as high as on direct-current motors, then the power factors with the same magnetizing and other conditions would have been approximately 4 per cent. lower. This lower power factor would not have made any harder condition on the supply circuit, but actually would have made a somewhat easier condition, as the supply system would have furnished about 8 per cent. less kilovolt amperes. For lower speeds this difference in power factor will be greater, and less for higher speeds. A high power factor at start, obtained by the use of resistance in series with the motor by high internal losses which do not represent torque, is, therefore, a detrimental condition rather than a good one, as it means increased kilovolt ampere expenditure for a given torque. This is merely given as an illustration showing that power factor in itself is not a true indication of conditions, but must be accompanied by other data. I do not give this as a criticism of these motors, but as a general condition found to a greater or less extent in all alternating motors.

STEINMETZ DISCUSSION.

In opening his discussion Mr. C. P. Steinmetz said he was pleased to agree with Mr. Lamme in considering the relative position of the repulsion motor, the plain alternating-current series motor, and the alternating-series motor fed by a transformer; and that he was pleased to see that Mr. Lamme has come to the same conclusion to which he and Mr. Eickemeyer had come in this early work; that is, that the only way to make an alternating-current series motor to operate at reasonably satisfactory power factor was to combine as high armature reaction as possible with as low field excitation as possible, then increasing the ratio of armature magnetism to the field, thus eliminating the current you cannot use; otherwise one will strike a standstill. As to assuming that the alternating current is non-inductive, no electrical engineer has yet designed a circuit traversed by alternating current which is really non-inductive. In the early work of Mr. Eickemeyer careful investigation was made on this subject by having the motor designed so that the relationship between the armature magnetic force and the field magnetic force could be varied, and it was found with that particular motor, using ratios somewhere between 3½ and 4, that is, where the armature reaction was between 3½ and 4 times greater than the field action, the best condition was reached. That is to say, if the total induction increases the armature reaction beyond that we lose more by increasing the induction of the field. With a short-circuit surrounding the armature, this point was reached at the lower value of armature reaction. However, that work was done at very high frequencies; that is, with motors where the polarity pitch was much less than they must be with the present frequencies, and undoubtedly with a change from these high frequencies of the early days to the frequencies considered here, which are about a quarter or less than those old frequencies, we can go to a further extent in this direction. However, attention is called to the fact that there is an ultimate limit between the ratio of armature reaction and the field excitation; otherwise you could say you could, by making the armatures 100 times as strong as the field, get any unit of power factor practicable; but you reach a maximum point and you cannot go beyond that without losing again.

The fact is that the repulsion motor has inherently such a high power factor that even with a considerable air-gap an air-gap which is impossible with the ordinary induction motor we can run to magnetic saturation and with large starting current; this magnetic saturation is approached and passed in part of the magnetic structures, in the base of the field and armature, and that causes the falling off, as we observe in the direct-current motor. It is not feasible to go to anywhere near such saturation as in the direct-current motor, but while we approach saturation, it is not necessary, but means a small motor.

Regarding the relative proportions and material of the repulsion motor and the alternating-current series motor, Mr. Steinmetz agreed with Mr. Lamme as far as his conclusion goes; that is, by using one and the same motor, the alternating-current series motor, first as a series motor and then as a repulsion motor—and experimental investigations have been made in that direction—by using a repulsion motor and running it as an alternating-current series motor led to exactly the opposite result, that the series motor is decidedly larger in weight and lower in efficiency. The explanation is simple. One reason why that the armature is not absolutely non-inductive, and the result is that if you calculate the power factor from the inductance of the field, assuming the armature is non-inductive, you get a higher power factor than exists in reality, because there is a self-inductance in the current of the primary and secondary, and self-inductance in the armature. While small, it is still there. You will find it in all alternating-current systems. Both observations are, no doubt, right, but in the repulsion motor by using this transformer we derive a high power factor at relatively low speeds and thereby are permitted to apply the standard induction motor design; that is, the distributed winding—the primary winding or field winding being distributed around a circumference—the secondary winding meaning low inductance winding. The induction motor has been made a commercial apparatus only by going to the distributed winding, but induction motors are still built and operated with definite polar projections, but they are inherently lower in power factor than motors with the distributed winding. By applying the same principle to the repulsion motor, we get thereby a considerable decrease in the self-inductance of the circuits and thereby are permitted to get close to saturation, in turn reducing the size and weight. Such a winding, however, for a plain series motor is not satisfactory, because in the series motor, as the original investigations of ten years ago showed, it is essential to have a definite polar projection to get good power factor, so that the motors considered, while they are a development of the same type, are of an entirely different mechanical structure. A motor which is a good series motor will make a very poor repulsion motor; the repulsion motor is larger, heavier, and more efficient. You cannot take one and the same motor and run it first as one and then as the other and draw general conclusions, because the transformer feature introduced requires redesigning and nullifies comparisons based on one particular design.

Mr. Steinmetz said that comparing the present alternating-current motor of the plain series or repulsion type with the highly developed direct-current motor, we find a somewhat lower efficiency in the

alternating-current motor, and it has somewhat larger weight. His personal opinion is that the difference is altogether less than should be anticipated, considering the short time of the development of the one and the longer time of the development of the other. The two types are not directly comparable. Take, for instance, the question of weight. In the direct-current motor we must have definite polarity, which requires a larger radial depth and a distributing winding of the repulsion motor, hence the outer turn of the field structure would be impossible in the repulsion motor and with the same external diameter there must be larger diameter in the repulsion motor. This throws out a direct comparison. As to the question regarding the relative efficiency, the internal proportioning of the motor is different. In the modern direct-current series motor the field is much stronger than the armature; in the repulsion motor we have realized a condition where the armature is stronger than the field. That would mean to correspond to the direct-current series motor in which we quadrupled the output of the armature, having four times as many turns. That would throw out of proportion any comparison to give the relative efficiencies; so, while the alternating-current motor has the additional losses of the hystereses and eddy currents, the proportions are changed and we cannot say that it means inherently low efficiency any more than we can say that the polyphase induction motor means a lower efficiency than the direct-shunt motor. We know that this is not the case, but that the polyphase induction motor has the same efficiency as the direct-current shunt motor on a general average. While at present for some years to come the alternating-current railway motor, as a new type of apparatus, will be handicapped by somewhat lower efficiency and somewhat greater weight, he does not consider this as inherent to the motor, but rather as more or less the result of a shorter development and does not consider it impossible that they should come to equality with, or even in some cases superiority to, the direct-current motor; but that is merely guessing at the future. All that he can say is that he does not see any inherent reason why the alternating-current motor should be heavier or less efficient than the direct-current motor. As to reversing, there are different ways of doing the same thing. We can change the point of entrance of the current in the primary wire without changing the brushes. We can feed into the primary winding at several different points in the repulsion motor and get the advantage of not shifting the brushes. As to whether it takes more copper in the repulsion than in the series motor, the repulsion motor takes more copper and less iron than the direct-current series motor takes, because the proportion of armature to fields are reversed as to the alternating-current series motor. He did not want to state positively, because he had not gone over the fields of the alternating-current series motor with sufficient care, or tested the ordinary current series motor with modern frequency; but his impression is it would be about the same as the direct-current motor. The plain series motor will have a smaller armature diameter than the repulsion motor, probably larger external diameter, more iron and less copper, but in general he does not expect there will be any inherent difference between the two types.

ARMSTRONG DISCUSSION.

In reply to questions by Mr. Ralph D. Mershon, Mr. A. H. Armstrong said that as to designing a repulsion motor that at the same time will operate as a good direct-current motor, one can make a repulsion motor to operate on direct current good enough to help through a town along right of way, but cannot make a good repulsion motor and a good direct-current motor in the same structure, any more than one can make a good series motor both alternating and direct. One feature or the other has to be sacrificed, and the preponderance of interest will determine which. As to the potential of the motors, a good repulsion motor can be wound for two or three thousand volts on the field without the use of transformers; the exact voltage is open to experimenting. Nothing is known about the effect of constant jarring and crystallization of insulation at high potentials on a railway car. Control can be either by a compensator or resistance or some method like that, with a good potential in starting—there are a number of methods. Such control would hardly be used at high potentials in service calling for frequent stops. If you stop once in five miles the slight difference in efficiency in starting would have no effect on the general efficiency of the system as a whole. You would gain one or two per cent. in the average of the car or train, which would not compensate for the complication. One can consider two or three thousand volts entirely feasible on the field of the motor without any intervening machinery. That, however, is open to experimentation and development. So far as the motor goes, it can be wound to that potential, but whether that motor would successfully withstand the shocks of railway service is a matter to be found out.

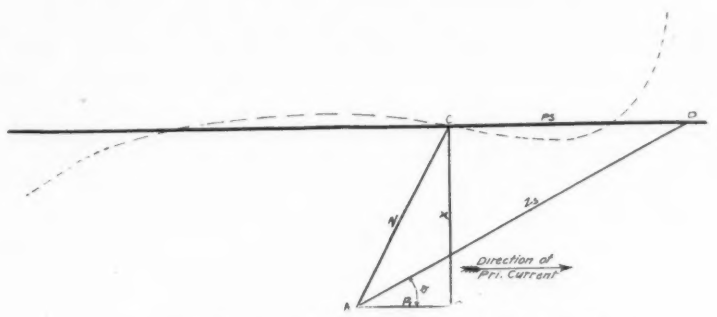
As to the weight of alternating-current motors and direct-current motors, that is an open question. The question of the capacity of direct-current motors has been very carefully worked out by the different engineering companies during the last two or three years, much time and labor has been spent in determining their exact capacities for a given piece of work, standards have been adopted and the matter has been worked down to a fine point with relation to direct-current motors; and to attempt to compare a piece of apparatus not yet in commercial service with a standard piece of apparatus developed for fourteen years, is hardly fair, and it is almost impossible to give a definite answer to the question. It can be said roughly that the motor will weigh somewhat more than the direct-current motor, but just how much added weight there will be we do not know. As to the weight of the rest of the equipment, that would depend on the method of control. If you use a high-potential motor, 3,000 volts direct on the field, your control should not weigh very much more. If you use a low potential and install a transformer of 100-kw capacity in the car, you have the added weight of the transformer in addition to the translating apparatus.

In reply to a question as to how large an alternating-current motor we can get for a 33 or 36-in. wheel, Mr. Slichter said that a 100-hp motor could be placed there, but he could not say a larger motor could not be. Mr. Lamme said his company was building 150-hp motors which will go in on 33-in. wheels closely, easily on 36-in. wheels. They have determined that they cannot put 200-hp motors on 36-in. wheels. That is one limit.

MCALLISTER DISCUSSION.

In introducing his remarks Prof. A. S. McAllister, of Cornell University, said that in the papers presented mention is made of the fact that the repulsion motor, when driven against its torque, acts as a generator, and that when the negative speed becomes of a value such that its product with the torque exceeds the internal losses of the motor, the machine will feed energy back to the line. The analytical equations given by Mr. Steinmetz furnish an explanation of the cause for this action on the part of the machine. The equations used may be represented graphically by a simple diagram, which allows of a more ready interpretation than do the equations.

The diagram referred to is given in Fig. 1, where $X$ (the distance $B\,C$) represents the combined local (stationary) reaction of both the primary and secondary circuits, the latter being reduced to primary terms. The scale is ohms or volts for one ampere. The heavy line is the assumed locus and the broken line the observed locus. $R$ (the distance $A\,B$) is the equivalent stationary resistance effect of both circuits of the motor. Then $Z$ ($A\,C$) represents the stationary impedance of the motor, and the cosine of the angle $C\,A\,B$




IMPEDANCE (E. M. F.) LOCUS OF REPULSION MOTOR.

is the power factor at starting. When the motor operates at a speed $S$, the power component of the apparent motor impedance is increased by a certain value $P\,S$ ($C\,D$ in Fig. 1); $P$ being a coefficient depending upon the relative strength of the field which causes the generation of e.m.f. in the armature conductors at speed $S$, and hence depends upon the position of the brushes. $P$ is here, as in the equations, assumed constant and the e.m.f. for each primary ampere due to $P\,S$ is assumed to be in phase with the current supplied.

Fig. 1 shows: $PS = R$, the apparent impedance of the motor becomes $X$; the current is $\frac{E}{X}$ and represents no energy flowing either to or from the motor; that is, the machine is operating as a generator and supplying its own losses. A further increase of negative speed causes the power component of the apparent motor impedance to become negative, indicating that energy is flowing from the machine. This action of the machine was illustrated by curves which were the results of tests of a certain repulsion motor, while other curves gave the calculated performance of the same motor, proper substitution having been made in the equations. Referring to the theory of the repulsion motor, Mr. Steinmetz states that the current which flows locally in the circuit formed by the brush and an active coil tends to a reduction of the power factor at high speeds; which statement Prof. McAllister said may be taken as an explanation of the fact that the power factor observed in the case of high speeds is much below that calculated, as shown by the curves just referred to. The neglect of the counter torque due to the local current flowing in the coil under the brush leads also to error in assuming that the repulsion motor tends to increase indefinitely the speed of its rotor as the applied e.m.f. is increased or as the load is decreased, since in reality experiment shows that the rotor tends to reach a certain speed above which, if it be driven mechanically, it acts as a brake.

Prof. McAllister then deduced certain equations, and said that the discrepancies between the assumptions made and the physical facts involved will be evident from a study of the formation of these equations, which become identical with the approximate equations of Mr. Steinmetz if for each value used above there be substituted given equivalents.

## Modern Methods of Operating Machine Tools Electrically.

Before the Engineering Society of Columbia University on Tuesday, February 2, Mr. Putnam A. Bates, an engineering graduate of the University, and well known as connected prominently with the management of the Crocker-Wheeler Company, gave an interesting lecture on "Modern Methods of Operating Machine Tools Electrically." The lecturer was appropriately introduced by the president of the Society, Mr. Gustav Wittig, and at the close the members expressed themselves as greatly pleased, passing a vote of thanks to Mr. Bates. The general text of the lecture follows:

It is particularly gratifying to the electrical engineer of to-day to note the fact that through the handiwork of his profession in making the use of electricity possible in commercial arts, its adoption has not only become very general, but is looked upon practically as a necessity. The great flexibility, comparatively low cost of installation and economical distribution of electric power, have given it a firm standing in general machine shop equipment. The question, therefore, of whether or not in machine shops power shall be distributed by means of electricity, is to-day hardly considered, as the advantages obtained by this method have been so successfully proven that there is little room left for doubt. Hence, the subject which is given attention is what method of electric distribution shall be adopted and in what manner shall the electric motors be arranged with respect to the work which they have to accomplish.

In considering the subject of individual drive, some have said "that while considered alone and for the individual tool, this method is ideal, yet the objection will occur that the enormous multiplication of small motors means increased complication and greatly increased cost, and that if this method is employed it should be limited to tools requiring from 5 to 10 hp and upwards, and that group drive should be used where the tools require less than these amounts."

If the saving in the coal bill due to the decreased losses in transmission obtained by individual drive throughout a machine shop or factory, only is to be considered, the objection above referred to might in a measure be correct, but as a matter of fact the coal bill in a year amounts to such a small percentage of the total operating expenses of any manufacturing establishment that a small variation in this one way or the other hardly merits more than passing consideration.

The element in our factory costs, which requires our most careful consideration is that of the labor cost involved in turning out a given piece of work. A very small percentage of decrease in our total labor bill will, as a rule, justify a greatly increased first cost, provided that cost will directly bring about the reduction of labor. Besides eliminating the disadvantages of line shafting, belting and the inflexibility of location, the individual drive of machine tools by electric motors increases the efficiency and output of machine shops. It is not necessary, therefore, to lay down any specific line of demarkation as to the size of the tool on which it would be advisable to apply an individual motor, but rather to consider in the case of each particular tool the class of work which is to be done and the character of the shop in which the system is to be installed. It can then be determined as to whether the increased facilities which the individual motor-driven tool affords, will not offset the objection claimed against the individual method of tool drive, which is "greater first cost." These increased facilities lie in the direction of variable speeds, under instant control, over any range, with every speed constant regardless of the load, the ability to maintain high cutting speeds due to superior facilities for manipulation and the absence of shut-downs from belt troubles.

If we fail to find that the advantages just mentioned offset the only objection claimed, before dismissing the problem there must be credited against the first cost of the individually-driven tool the cost of countershafts, hangers and belts, also the cost of the increased power to overcome friction losses due to the shafts getting out of line and the tool operator's time lost in lacing and repairing the belts, to say nothing of the unhandy methods which are required for the starting and stopping, and shifting from one speed to another. Upon giving all of these points careful consideration, we will find that the first cost of the individually equipped shop is not much if any greater than one arranged for group drive. Particularly is this so in the face of the advantages obtained by the former method of drive.

The practice of using portable tools and bringing the tools to the work rather than the work to the tools, which is becoming so popular to-day is only a further development of the individually-driven motor tool idea. The portable tool, which cannot be operated unless it is driven by an individual electric motor, serves as an excellent example of what we should endeavor to accomplish in our efforts to make all our machine tools as simple and useful as possible. They should not be so arranged that they must always be in one particular location in a shop, for it may be desirable to use this portion of the shop, as time goes on, for other purposes, or possibly it will become necessary to crowd in additional machines of the same type as those already in use, and it is not every shop that is so arranged as to permit of the installation of additional tools without necessitating very awkward connections to the line shafting.

If the tools are all individually driven, this difficulty does not exist. While the individual method of electric drive provides a material reduction in the cost of power, this factor is not its greatest recommendation, the greatest benefit being derived from the elasticity which is obtained only by the adoption of this method. With individually-driven tools there is no longer any necessity for the rigidity of arrangement which obtains with shafting and belting, so that if it becomes necessary to rearrange the plant at any time, the expense is reduced to a minimum.

The valuable light which possibly the shop or factory building has been constructed especially to provide, can only be maintained by avoiding the adoption of any equipment requiring overhead construction which must necessarily prove a hindrance in this regard. A study of the evolution of the introduction of electricity into industrial plants, first for lights, second for cranes and elevators, third for constant-speed motors for group drive and lastly variable-speed motors individually connected to the tools, indicates clearly that the group method can hardly be compared with individual drive so far as advantages are concerned, or it would not have been necessary for manufacturers to spend their energies in developing the ingenious applications of individual motor-driven tool equipments, which have been offered to the market during, we may say, the past year or so.

While the driving of groups of tools by means of constant-speed belted motors permits of the elimination of very heavy belting and long line shafts, and in this regard is an advance towards the ultimate end—electric drive of individual machines—it does not and cannot offer that which is by far the most important feature of electric drive; i. e., the possibility of placing the speed control of the driven tool at the immediate will of the operator.

With these preliminary remarks as to general problems governing questions which have to be determined before a purchaser can properly select the electric system which is best suited for his own plant, I will pass now to a description of a particular system of electric drive which gives certain positive advantages due to its methods of variable-speed control. The system described is one designed and perfected by the Crocker-Wheeler Company, of Ampere, N. J.

The ordinary belt-driven tool usually has a speed range obtained by mechanical means, of from 20:1 to 50:1, with increased speed steps of about 30 to 50 per cent. The Crocker-Wheeler system for the multiple voltage operation of machine shops not only extends the speed range, but also reduces the speed increment per step to about 10 per cent., which has been found by experience to be as small an amount as would be desirable to use. This system is a method of electric power distribution at different voltages, which enables standard motors to be operated at various speeds by changing the potential of the current at the motor terminals. The generating plant supplies the highest voltage of the system. This voltage may be termed the primary and is divided by a three-unit balancing transformer into three unvarying voltages of unequal value, which are maintained between the wires of a four-wire circuit, various connections of which offer six different and distinct voltages.

The principle of which this system of speed control is based is that in a separately excited shunt motor the speed of the armature is proportional to the voltage supplied to its terminals. If this voltage remains constant the speed will remain constant even with varying load. It is the function of the balancer to maintain these voltages constant and to accommodate the unbalance of currents between the four wires of the distribution circuit. As the conditions of machine tool operation will result in the various motors of the system being nearly equally distributed on the circuits, the unbalanced currents will be but a small percentage of the total current taken by all the motors. The intermediate wires of the system are extended to the variable-speed motors only, the constant-speed and crane motors and the lighting being supplied in the usual manner from the outside wires at the generator voltage.

Those motors requiring variable speed are connected to the four-wire circuit by means of a controller of the drum type adapted for mounting on the tool in a place convenient to the operator. The action of this controller is such that as the drum revolves the armature terminals of the motor are connected in the proper sequence to the six circuits afforded by this system, and the travel of the drum from one position to the next is so quickened by the action of a spring that contacts are made and broken at a high rate of speed, preventing the formation of arcs and eliminating the possibility of the drum stopping between contacts. This gives six fundamental motor speeds, which are subjected to a further refinement by varying the motor's field strength sufficiently to cover the gaps between them.

The speed range obtained on the voltage points alone is 6:1, being proportional to the ratio of maximum to minimum voltages. The addition of field resistance points above the highest voltage points extends the total range of the controller to a value of 10:1. For exceptional cases the range may be increased to a maximum of 12:1, the proper range in any case being determined by the character of the machine and the work which it performs. The Crocker-Wheeler system as outlined has certain positive advantages of which the most important are the following: 1, variable speed, under instant control, over any range; 2, every speed constant regardless of the load; 3, controllers simple and convenient of attachment; 4, the horse-power of the motor but slightly in excess of that required by the tool; 5, output of machine tools much greater than when they are belt-driven; 6, easy of adaptation to existing shops with a two-wire system of electric power distribution; 7, employment of standard motors; 8, ability to maintain high cutting speeds due to superior facilities for manipulation.

Motors used in an ordinary shop equipment may be divided into Classes A, B, C or D, according to the nature of their duty. Class A is the constant-speed motors such as drive groups of small tools by shafting, this class being kept as small as possible consistent with best judgment based on a careful study of all of the advantages which should be credited to the individual drive idea in comparison with the one disadvantage which may or may not exist, that of a possible slight increase in first cost. In many cases, however, even this one disadvantage may be lost sight of in the face of the advantages which are to be obtained through flexibility of location and ease of manipulation. Class B, controllable-speed motors, generally of the series-wound type, as used on cranes. The duties which the motors in both of these classes have to perform is such that their demand for current is intermittent and often excessive, consequently they are best suited for connection to the outside mains and such speed regulation as they may require can be obtained by rheostatic control.

The other two classes, C and D, are controllable-speed motors for the drive of individual tools where the speed should be maintained constant at any one of a number of fixed values. Class C covers driving pressure blowers, punch presses, planers, etc., which demand approximately constant torque at all speeds, the horse-power diminishing with the speed. This characteristic of the tool being identical with the power characteristic of the motor on this system, the normal horse-power of the motor need not be greater than the maximum demanded by the tool.

Class D covers those motors operating lathes, boring mills, etc., where the torque increases as the speed diminishes. If the range required by these tools is to be obtained by using a motor through its maximum range, the motor would be very large and unnecessarily expensive. For this class a speed range of approximately 3:1 has been selected as a basis for the determination of the most suitable sizes of motors with respect to the duty which they have to perform. A motor, therefore, to give a constant horse-power throughout this range, must have a normal rating of about twice the horse-power required by the tool. This range, however, may be extended to cover the entire range required by the tool by using one or more additional gear runs. The method is an advantageous compromise between the use of an excessively large motor with no gears and a constant-speed motor with many gears.

The extreme facility of manipulation which this system affords enables the machinist to push his tool to the highest limit of cutting speed, thereby giving large increases in output. Results show that as much as 20 per cent. increase in output over a belt-driven tool may be obtained by this system of motor drive. As by actual test in commercial plants, it has been demonstrated that 2¼ per cent. increase is sufficient to warrant the outlay necessary for individual drive, the possibility of large saving in operating expenses through the adoption of this system is at once apparent.

## Local Meetings of the American Electrochemical Society.

The first meeting of the New York Section of the American Electrochemical Society was held on January 26 in the Chemists' Club, New York City, the attendance being nearly 60 in spite of most disagreeable weather. The first meeting of the Philadelphia Section was held on February 5 in the Engineers' Club, of Philadelphia, the attendance being 11. As far as the papers presented were concerned, both meetings were a full success and the discussion which followed the reading of the papers was in both cases animated.

The meeting of the New York Section was opened by the chairman, Prof. Charles A. Doremus, who dealt with the success of the Society and explained why New York City should have a local section. Mr. A. von Isakovics acted as secretary.

In a paper on "The Commercial Electrolysis of Water," Prof. J. W. Richards gave a review of the various commercial systems for producing hydrogen and oxygen by the electrolysis of water. A solution of caustic soda, with iron electrodes, seems now to be generally used. To keep the products of electrolysis—oxygen and hydrogen—separate from each other is the main technical problem in the design of the cell. This is universally done by means of a diaphragm, but according to the nature of the diaphragm the following three classes may be distinguished: First, non-conducting porous diaphragms filling the whole cross-section of the cell, as in the cell of Schmidt; second, solid partial partitions of a non-conducting material, as in the cell of Schoop; third, metallic partial partitions, as in the cell of Schuckert. In the latter case the metallic partition does not conduct the current, since otherwise hydrogen and oxygen would be evolved at its two sides. This is at least the case as long as the e.m.f. at the terminals of the cell is kept low. Such partial metallic diaphragms are, of course, preferable to glass on account of durability.

In a paper entitled "Thermochemistry of Electrolytic Dissocia-

tion," Mr. C. J. Reed attacked a previous paper of Dr. J. W. Richards on the same subject and claimed that his calculation of the neutralization heat was essentially based on the assumption of complete dissociation, which contradicts his other views. Dr. Richards' method of calculating the formation heats, on the principle that it is an additive property, is claimed by Mr. Reed to be incorect in many cases. In the discussion which followed, Dr. Richards maintained his original position concerning the calculation of the neutralization heat and stated that the rule of Hess for calculating formation heats applies essentially to very dilute solutions. It is, of course, well known that this consideration does not apply to the case of insoluble salts.

In a paper on "Ferro Alloys," Mr. A. J. Rossi gave an account of his researches on the manufacture of ferro alloys in the electric furnace and discussed especially his method of reduction by means of aluminum. It is in principle similar to Goldschmidt's aluminothermic method, but while the latter uses aluminum in powdered form, Rossi applies the aluminum in waffles, ingots, scrap or the like, which are charged in the electric furnace. When the current is started, the aluminum melts in a very few minutes, and into this molten bath he then shovels the metallic oxides to be reduced. As applied to ferro-titanium, for instance, the method consists in charging in the bath of aluminum titaniferous iron ores, i. e., titanic oxide associated with iron oxide. Iron is reduced first, forming a bath in which the titanium reduced by the aluminum in its turn dissolves, yielding the ferro-titanium. Mr. Rossi exhibited a very interesting collection of ferro metals, which he had produced in the electric furnace, including ferro-titanium, ferro-tungsten, ferro-molybdenum, ferro-chrome, ferro-silicon, ferro-manganese, copper-titanium with accompanying slags.

A note by Mr. I. J. Moltkehansen referred to an observation which he had made in electrolyzing a concentrated silver nitrate solution with two platinum wires as electrodes. He obtained two deposits of similar appearance at both electrodes. Mr. Reed suggested that the anodic deposit might have been silver peroxide.

The meeting of the Philadelphia Section was called to order by Mr. Carl Hering as chairman, Dr. S. S. Sadtler acting as secretary. A paper on "Composition and Reduction of Voltages" was presented by Dr. J. W. Richards. It relates to the calculation of the e.m.f. in the case when two or more different chemical actions are simultaneously going on. For instance, if a solution of a mixture of copper sulphate and sulphuric acid is electrolyzed between copper electrodes, the question is what must be the voltages at the terminals of the cell. If a certain number of coulombs is consumed in depositing copper, while the balance of the coulombs evolves hydrogen, the energy of both reactions can easily be calculated. (The energy required for depositing copper is, of course, zero as long as the Joulean heat is neglected.) By dividing the total energy required for all the different reactions which go on by the total number of coulombs passing through the cell one gets what Dr. Richards calls the composite voltage. Some numerical examples were given by the author.

In a paper entitled "Formation of Hypochlorites," Dr. S. S. Sadtler discussed some experiments concerning the influence of the composition of a solution and the material of the electrodes on the formation of hypochlorite. The electrolyte was a salt solution containing an alkali and the results were given for different concentrations. He found peroxide of lead electrodes to be the best for his purpose.

In a paper entitled "Theory of Electromotive Forces," Dr. R. Gahl applied in an interesting manner the theory of electrons to the calculation of e.m.f's. The result which he finally reaches is the well-known formula of Nernst for the e.m.f. of a galvanic cell, but Gahl's method is novel in so far as he bases his considerations on the chemical equilibrium between charged ions, discharged atoms and electrons. For instance, in the case of the monovalent sodium ions he considers the chemical equilibrium between the charged sodium ion, the discharged sodium atom and the positive electron.

A brief note by Mr. E. W. Smith maintained that what is generally called overvoltage must be assumed to be contained in the second term of the Gibbs-Helmholtz equation which contains the temperature coefficient. Dr. Gahl doubted the correctness of this assumption since the Gibbs-Helmholtz equation assumes the discharge of the cell to be absolutely reversible, and the reversibility is doubtful for those processes which are concerned in what is generally called overvoltage.

## Canadian Niagara Falls Power Development

In a report to the stock and bondholders of the Electrical Development Company, of Ontario, Limited, which has been printed in pamphlet form with a number of illustrations, an account is given of the present status of the work on the power plant being erected on the Canadian side of Niagara Falls, and which, when completed, will generate power for transmission to Toronto.

Vice-President and General Manager Frederic Nicholls gives an account of the organization of the enterprise and the general progress of the work. From this we learn that on January 29, 1903, an agreement was entered into between the Queen Victoria Niagara Falls Park Commissioners and Messrs. Mackenzie, Pellatt and Nicholls, granting rights to take water from the Niagara River at Tempest Point, for the purpose of generating electricity to the extent of 125,000 electrical hp. On the 18th of February, 1903, the Electrical Development Company, of Ontario, Limited, was incorporated under the authority of the Legislature of Ontario, with a capital stock of $6,000,000. At a meeting of shareholders of the company, held on March 21, 1903, the agreement made between Messrs. Mackenzie, Pellatt and Nicholls and the Queen Victoria Niagara Falls Park Commissioners, was acquired by the company.

Since that date no time has been lost in expediting operations in order that the enterprise may be income-producing at the earliest possible period. Contracts have been awarded for cofferdam, tail-race tunnel, wheel pits and electric generators, and preliminary plans have been completed for the construction of the power house. Contracts for the water wheels and head gates have yet to be let, but the engineering data for all of this work is about completed, and tenders will be called for at an early date.

The Toronto & Niagara Power Company, having the charter right to expropriate lands, has been equally active in securing a private right of way between Toronto and Niagara Falls, on which the pole line for the transmission of energy will be constructed. About 85 per cent. of the right of way, having a minimum width of 80 feet, has been purchased to date. The right of way has been located in such manner that in addition to the pole line provision is made for a double-track railway, should future developments warrant its use for such an enterprise.

With a view to providing manufacturing sites for those who may become purchasers from the company of power for industrial or electrochemical uses, some 530 acres of land have been purchased fronting on the Chippewa River, situate about two miles from the town of Niagara Falls, three miles from the confluence of the Chippewa and Niagara Rivers, and about 3½ miles from the point at which the Chippewa River has entrance into the Welland Canal. These lands have a river frontage of over 1½ miles. The purchase price averaged about $70,000 per acre. It is stated that the wisdom of this early purchase is evidenced by the fact that similar lands in the vicinity are now held at a great advance over this figure, caused no doubt by activity due to the development at Niagara Falls now under way.

Installment payments on the company's bonds have been promptly met and receipts have, up to the present, been in advance of expenditures. The cash balance at the credit of the company, in the hands of the National Trust Company, trustees for the bondholders, amounts at present to about $1,000,000. As all the works of the company are being pressed forward to completion simultaneously, progress payments will be required more rapidly in the future, but calls have been so arranged that ample funds will be available to meet all expenditures as the work progresses.

Mr. F. S. Pearson, consulting engineer to the company, gives a report of progress on the construction of your power plant at Niagara Falls.

At the time this work was commenced it was recognized by all those conversant with the plans that the greatest difficulties the company would have to encounter would be in the installation of the cofferdam and the commencement of the work on the main tail-race tunnels. It was considered by many that it would be impossible to carry out the work as outlined on the original plans. Both of these serious problems have been solved in a very satisfactory manner and without serious expense or delay.

It was assumed in the original estimates that the depth of the water would be about 8 ft. as a maximum on the line of the cofferdam, and in view of the fact that this dam was to be located in the midst of the rapids of the Niagara River it was expected that it

would be a difficult operation to build a structure that would withstand the excessively rapid current. As the work on the cofferdam proceeded and it became possible to ascertain the depth of the river, it was found that there was 26 ft. of water, but even with this extraordinary depth and the rapid current, the work on the dam has proceeded continuously and at a rapid rate when the difficulties of construction are considered. The most serious part of this work is now completed and there remains only a short spur to connect with the shore in shallow and still water. The dam as constructed is thoroughly stable and secure, as one cannot feel a tremor in any portion of the work and it is evident that the dam is well designed for the purpose intended.

A long section of this dam was constructed over a portion of the river bed covered with very large boulders, on which it was necessary to place the cofferdam, fitted to the boulders as well as was possible under the conditions. Naturally a cofferdam built on such a sub-stratum would show great leakage, and it will require considerable work and time to stop the flow of water under the dam. An inspection of the work at the present time shows that very little water is leaking under the dam, even between these boulders, and there is no reason why the greater portion of these leaks should not be stopped. At the present time the amount of water coming through under the dam is not sufficient to seriously interfere with the construction of the work, as it could be handled by flumes and canals, if necessary. The larger portion of these leaks, however, will be stopped in the next few months, and before the forebay construction is commenced. It can be safely stated that this cofferdam represents as great an undertaking in this line of work as has probably ever been designed or constructed.

The plan for the tail-race tunnel requires a portal under the falls. There have been various theories regarding the condition under the falls, as there are, at times, noticeable explosions, apparently due to compressed air, and it was confidently predicted by engineers conversant with Niagara Falls and the work thereabout that it would be impossible to open a tunnel portal at the point selected on the plan. In order to reach the line of the main tunnel a subsidiary tunnel of about 650 ft. in length was required, and to ascertain the conditions under the falls, as well as to provide for dumping the debris of excavation, an opening was planned about midway of this tunnel. It was anticipated that some trouble might be caused by the water when this opening was made, and the anticipations were more than borne out by the facts, as long before an opening was effected the subsidiary tunnel was flooded with water, which leaked through cracks at the face of the cliff. For several weeks the contractor had a great deal of trouble in overcoming this difficulty, but finally, after persistent and very creditable work, an opening was effected, which has completely drained the tunnel, and also proven that it is perfectly feasible to place the terminal of the main tail-race tunnel at any point desired.

The character of the rock encountered in the subsidiary tunnel is a solid shale, thoroughly tight, and there is not water enough in the tunnel to supply the air drills. In most places the rock is absolutely dry. This is an indication that there will be no trouble in driving the main tail-race tunnel, especially in view of the fact that there is now an opening from the subsidiary tunnel which would drain any volume of water which might come in through a fissure in the rock.

With this opening under the falls assured, and the cofferdam practically completed, the two greatest difficulties in connection with this work have been surmounted. The progress of the subsidiary tunnel (something like 14 ft. per day) is an indication of the progress the contractor should make on the main tunnel. The contractor for the wheel pit is erecting a large and efficient plant for the construction of this pit, and it is evident that he proposes to push this work in every possible way.

On account of the magnitude of the installation and the immense volume of water required for its operation under maximum conditions of load, there has been a question in the minds of the engineers as to the volume of water readily available for the work. This question arose from the assumption that the maximum depth of the water in front of the forebay was only about 8 ft. Plans were under consideration contemplating the excavation of a deep channel in the river beyond the cofferdam limits to provide for a sufficient volume of water. Now that the cofferdam is installed, and the great depth of 26 ft. of water has been found, all questions regarding the supply of water have been set at rest, as it is evident that the amount of water available is several times in excess of that required. While the great depth of the channel has made the construction of the cofferdam much more expensive, it avoids a large expenditure in excavation and absolutely assures the company as regards its water supply, thus compensating for the greater cost.

The plans for the work in general are being completed and contracts have already been placed for the wheel pit, tail-race tunnel and generators. The plans and specifications for the water wheels and iron work about the power station and pole line will soon be ready, so that the contracts for these can be placed within a short time.

The location of this plant is very advantageous and when completed it will be equal in all respects to any that have been proposed or constructed at Niagara Falls. On account of its advantageous location the cost per horse-power will be exceptionally low. With a transmission line to Toronto of capacity sufficient to deliver 30,000 hp, the total cost per delivered horse-power at Toronto will be as low, if not lower, than that for any other plant of a similar nature that has been constructed. The company should also build up a large business in the vicinity of Niagara Falls and along its transmission line, and with the low initial cost the financial success of the company seems assured, as on account of the low cost of its power it should be in a position at all times to meet competition with other concerns and at prices which will realize a good net income.

Mr. W. T. Jennings, chief engineer of right of way, reports that the total distance between the generating station and Toronto is 75½ miles. The location has been selected with a view to the utilization of the right of way lands not only for electric power transmission lines, but for railway purposes, and in this respect it may be noted that the country traversed does not present serious engineering difficulties. Considering the advantages which may thus be obtained for very rapid rail transit, by electric power, between the Niagara River frontier and Toronto, the small additional distance over air lines between fixed points is inappreciable from an electrical transmission point of view, while for the railway of the future, with a train service rated at 100 miles per hour or more, it is obvious that the best alignment and gradients the country can economically afford are necessary.

A private right of way has been largely secured through the districts traversed, on a minimum basis of 80 ft. in width (with enlargements where necessary), to provide for pole transmission lines and for a double-track railway, while where forest land is passed through the right to cut down trees, etc., has been secured for such extra distances as may be advisable to insure freedom from accident, interruption to electric transmission or to train service. Tenders for fencing the entire right of way have been invited.

## Electrical Engineering at Union University

During the winter term of 1904, non-students of Union University are admitted as special students in the following courses of lectures given by or under the auspices of the Department of Electrical Engineering: Post-graduate lectures in electrical engineering, by Chas. P. Steinmetz, professor of electrical engineering; general lectures in electrical engineering, by specialists of the General Electric Company and Dr. Steinmetz; engineering mathematics, by Dr. C. P. Steinmetz; electrochemistry, by C. A. Ernst, Ph.D., assistant director of Electrochemical Research Laboratory of the General Electric Company.

An indication of the excellent work being done at Union is given by the following list of lectures by specialists delivered during the fall term: "Introductory," by C. P. Steinmetz; "Magnetism and Induced Electricity," by R. Neil Williams; "Historical Development," by W. S. Andrews; "Direct-Current Machine Action and Application," by H. F. T. Erben; "Direct-Current Machine Calculation and Design," by W. F. Dawson; "Boosters and Variable-Speed Motors," by H. Bickerstaff; "Electrical Calculation of Alternating-Current Generators and Synchronous Motors," by W. J. Foster; "Electrical Calculation of Induction Motors," by A. E. Averett; "Mechanical Design of Generators and Synchronous Motors," by H. G. Reist; "Mechanical Design of Induction Motors," by H. G. Reist; "General Transformer, Boosters, Frequency Converters, etc.", by C. P. Steinmetz; "Alternating-Current Transformer," by W. S. Moody; "Potential Regulators," by E. F. Gehrkens; "Constant-Current Transformers," by M. O. Troy; "Reactors," by J. J. Frank; "Technical German," by R. Neil Williams.

## New Telephone Patents.

THE MERCURY VAPOR COLUMN AS A TELEPHONE REPEATER.

Probably almost every electrical man is aware of the multitudinous attempts to solve the problem of the telephone repeater and many will recall the Glidden offer of several years ago of one million dollars for a practical apparatus of this type. The earlier suggested repeaters were all of the same kind, being a mechanical combination of telephone and microphone, with either the same or interconnected diaphragms. Such instruments appear all right in principle and in the laboratory they will repeat with more or less success. When, however, the current undulations to be repeated are received over a reasonably long line, approaching the requirements of practice, the received energy is so small, having been dissipated and attenuated from many causes, that its value on the far side of the repeater is almost always less than were the repeater entirely removed from the circuit. This result may be traced to the large mass of microphone parts which must be set into instantaneous motion, coupled with the fact that any sluggishness in their response means almost an entire loss of clearness.

The first step in the right direction and a very promising one was made some few years since in the repeater of Mr. Erdman, which abandoned any solid connection between the receiving and transmitting parts, substituting therefor a pneumatic connection. In brief, the receiving magnet was made to control the outlet of a

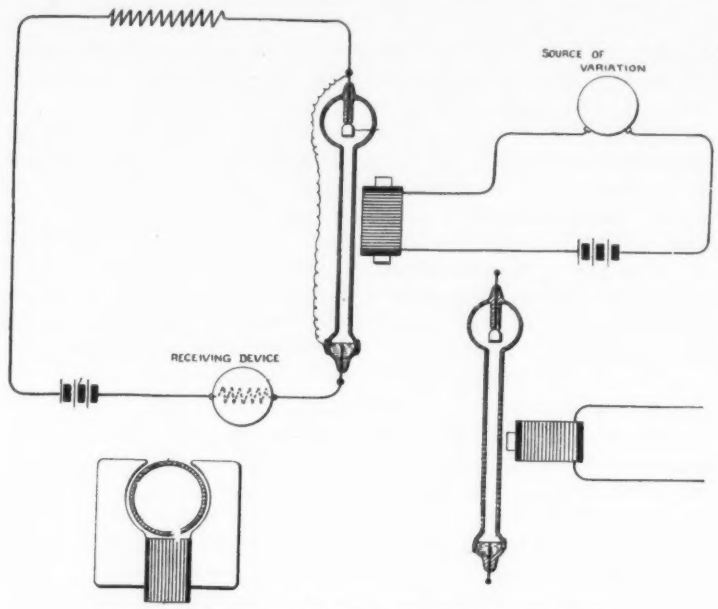



FIG. 1.—HEWITT VAPOR TUBE TELEPHONE REPEATER.

fine tube through which air was flowing at high velocity supplied from a receiver. Near the valve end the tube communicated with a chamber closed by a diaphragm which was connected to the microphone. By carefully balancing the valve of the receiving part and properly designing it, a very small received energy could be made to produce an enormous effect upon the repeating microphone; but this speed of response was too low and this repeater failed, because it muffled the speech. It therefore becomes apparent that some electrical or equally instantaneous means of associating the receiving and transmitter circuits must be found and this an association by which the energy of transmission is increased if a successful repeater is to be devised. Such means form the subject of a patent granted to Peter Cooper Hewitt and noticed briefly last week. According to the specifications, a mercury vapor column which seems to be lending itself to so many useful ends, is found to be very sensitive to a magnetic flux intersecting it, any variation in such flux causing its apparent resistance to change considerably. Now, it may be readily understood that if such a column can be made to maintain a constant resistance when supplied from a constant source of potential, then if it be placed in series with a telephone, no sound will be heard. Let, however, a receiver magnet, through the coils of which an undulatory voice current is flowing, be brought up to the column, and there will at once occur a disturbance in the first telephone due to direct resistance variations of the column. The patent drawings referred to in describing this combination are given in Fig. 1, which shows three possible arrangements of the receiving magnet; the first with the axes of the core and vapor tubes parallel; the second, with these perpendicular, and the third with the body of the vapor tube completely filling the interpolar space, probably the most efficient arrangement. Pactical trial only can probe whether or not this apparatus solves the troublesome problem of repeating on long lines; but, nevertheless, the possibility of a solution is made more evident thereby.

A NEW RECEIVER.

Now that the principles of good receiver design are quite generally known, very few radical departures are to be looked for, such improvements as are made being chiefly along the line of improvements in detail construction to slightly facilitate manufacture or repair. Such improvements are those described in a patent for a receiver just granted to Messrs. S. Sands and C. Cadden, of Cleveland, Ohio, and assigned to the Williams-Abbot Company. The novelty lies in two features. The first is the device for absorbing the mechanical stresses between the receiver and its cord. This is a stirrup attached to the magnet to which the cord braiding may be secured. The second is the provision of a threaded rubber annulus between the cap piece and casing proper. This annulus screws down upon the diaphragm, its external threads engaging threads upon the inside of the flange of the diaphragm cap of the casing proper. The cap is then mounted by engaging with threads upon the internal surface of the annulus.

DOUBLE-DIAPHRAGM TRANSMITTER.

Mr. E. B. Fahnestock, of New York City, has now made farther developments of the double-diaphragm transmitter, the details of the construction of this novel instrument being given in a patent recently issued. Probably a sectional view will be of best service for showing the arrangement of its parts, such as that given in Fig. 2. This section is taken in a plane parallel to that of the mouthpiece. The outer cross-hatched portion is the casing into which the transmitter slides. This is so shaped as to form a shallow sound chamber for each of the two diaphragms. The part marked *C* is an internally-flanged ring, which serves as the foundation upon which the microphonic button is built. Secured to this on either side of the flange are the auxiliary diaphragm of mica, *N N*, which are pierced at the middle by the studs of the two metal-mounted carbon electrodes, *O*. Secured to the outer ends of these studs between a nut and spacing blocks are the diaphragm proper, *K K*. These are free at their peripheries, but are placed in recesses designed to prevent the direct access of the sound waves to the rear of them, a condition which the inventor states is conducive to clearness.

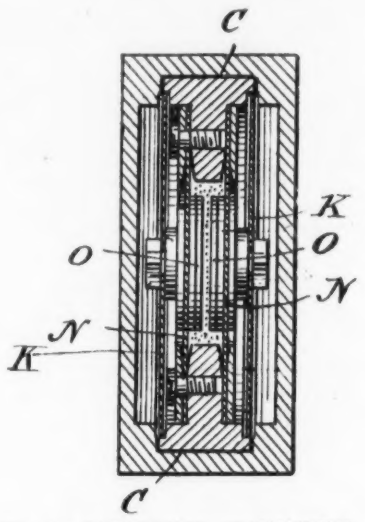



FIG. 2.—FAHNESTOCK TRANSMITTER.

CALL APPARATUS.

One would scarcely think that a telephone switch hook could do service as an automatic telegraphic sender, but nevertheless such a function has been assigned to it in an invention of J. D. Peachey, of East Orange, N. J. This invention provides that the starting of any call by a subscriber, denoted by his removing his receiver from the hook, will be followed at once by the registration by automatic telegraphic means of his number, in dot-and-dash code, upon a Morse register. To accomplish this signal the switch hook is given a long throw and moves under the influence of a heavy spring, the speed being controlled by a dash-pot. In its upward motion a contact piece attached to the hook trails over a series of properly spaced contacts through which the code signal is sent in. On the downward motion no contacts are made, as a deflecting spring throws the moving contact out of position. This particular type of signal would at first thought seem to be of no value; but it is probably designed to co-operate with its inventor's telephone fire alarm scheme, which has been already described in these columns.

PLUG EJECTING JACK.

A switchboard jack designed to automatically eject a plug inserted in it upon the sending in of a clearing-out signal has been

patented by R. G. Dunfee, of Fostoria, Ohio. The ejection of the plug is accomplished by a spring which becomes compressed by its insertion, being latched until the current from the ring-off releases its trigger through the agency of the clearing-out coil. The apparatus is probably of far greater value in theory than in practice.

SELECTIVE SIGNAL SYSTEM.

Another step-by-step selective signalling system has appeared, this time in a patent granted to G. Babcock, of Chicago, and assigned to the Stromberg-Carlson Company. This system has some features not usually included in such systems, the most notable of which is an indicator to show the central office operator on disconnection whether or not she has restored the line to normal. Unfortunately, this signal is associated with the connecting cords and not with the abnormal line, and the operator in order to correct any indicated error, must remember which line the particular cord in question was last used with. In some cases the locating of the desired line would be very easy, but where the operator's load was heavy, the very condition conducive to the failure to restore lines, the task of remembering which line was forgotten would be a most difficult one.

## American Lighting Development in Venezuela.

Some interesting contracts have just been placed here for various lighting equipments for Venezuela. A number of others have been decided upon and several orders are expected to be closed shortly for more American machinery to be installed in hydraulic and steam power plants in the same South American country.

Carlos G. Palacios, the chief engineer of the electrical end of the Caracas Gas & Electric Light Company, is now in New York on behalf of his company, and also for the Electric Light Company, of La Guayra, both of which concerns will be furnished with considerable American apparatus. Mr. Palacios was the introducer of American electrical machinery into Venezuela, where he has installed the majority of the leading plants—both water and steam power. Some twenty years ago he was connected with the old United States Electric Light Company, of Newark, N. J. The Caracas Company at present draws the bulk of its power—800 hp—from a 2,000-hp hydraulic plant, which is located at El Juaire, about 12 miles distant from the Venezuelan capital.. In the city it operates a steam plant capable of developing 500 hp, and equipped with McIntosh-Seymour engines, General Electric generators, and Babcock & Wilcox boilers. This steam plant is to be considerably enlarged and an outfit of 1,000-hp capacity will be put in. Crossley gas engines—four of 250 hp each—will be employed to operate Stanley alternating-current generators of 200-kw capacity each. The lighting plant to be installed at La Guayra—the port of Caracas—will have an initial capacity of 3,000 incandescent and 250 arc lamps. The power house equipment will comprise a 14-in. x 36-in. Hamilton Corliss engine, direct-connected to an 80-kw generator of Stanley manufacture. The boiler will be of Robb-Mumford type, 125 hp. It is anticipated that this plant will be doubled in capacity within six months.

Cuidad Bolivar, an important commercial city of some 15,000 inhabitants, located in the extreme end of Venezuela, on the Orinoco River, is to have an up-to-date American lighting and power plant, whose capacity in the first instance will be 800 hp. Mr. Palacios will act in an advisory capacity to the promoters of the new enterprise, who are wholly Venezuelans. Power will be generated by steam.

Projects are also under way to utilize two important water powers in North Venezuela. In the vicinity of Macuto a town of some 3,000 population, there is located a water fall no less than 2,000 ft. high and calculated to be able to develop 5,000 hp. At Juan Diaz about the same head and capacity are available. It is also contemplated to take advantage of a large water power named the Mamo Falls, capable of developing more power than either of the other two, but with less head.

The lighting plant at Valencia, which is a steam one of 300 hp, having a McIntosh-Seymour engine and a generator of General Electric manufacture, is to be nearly doubled in capacity. At Maracaibo the lighting plant, whose capacity is 1,200 hp, is to be extended. The present equipment comprises McIntosh-Seymour engines, Root boilers and General Electric generators. The water power plant which lights Merida is to be doubled in capacity. The existing machinery develops 400 hp. The water wheels are of Pelton built, direct-connected to Stanley generators. At Tachira the 300-hp hydraulic plant—Pelton wheels and Stanley generators—is to have 500 hp additional equipment.

# CURRENT NEWS AND NOTES.

*NEW YORK ELECTRICAL SOCIETY.*—The 241st meeting of the New York Electrical Society will be held at the American Institute, 19 West Forty-fourth Street, at 8 P. M., February 17. Mr. Ralph D. Mershon will lecture on "The Gas Engine for Central Station Service."

*RADIOACTIVE DINNER.*—The Technology Club, which is the New York Alumni Association of the Massachusetts Institute of Technology, had a "radium" banquet on the night of February 5. President Pritchett, of the Institute, made an address in which he expressed the hope that the day might come when the nation would draw on "Tech." for its administrators and leaders. The feature of the evening was a radium demonstration, the chief item being cocktails of fluorescent liquids rendered radioactive and glowing in the dark when lifted to the lips.

*ITALIAN POSTAGE STAMPS.*—As to the new Italian postage stamps noted in these columns last week, it is stated that the painter Michetti, who designed the new Italian postage stamps, has devised an ingenious detail for the two-centesimi stamps, which are in honor of Marconi—a telegraph pole from which the wires hang down useless. All the stamps were made at the desire of the King, who had come to the conclusion that Italy's stamps were no better than those of France, England and Germany, and did not reflect honor on a country known as the home of classical art. The other electrical stamp does honor to Volta.

*PURIFYING JUICES.*—A patent granted to Messrs. Alexander Kollrepp and Alfred Wohl, of Berlin, Germany, refers to some improvements in the electrolytic treatment of sacchariferous solutions of any kind, as juices of beet root, sugar cane or refinery juices. Essentially, the process of the inventors consists in the separation of the alkali by "electrodialysis," or by amalgamation on a mercury cathode, and in the binding of the acids, liberated at the anode, by basic compounds of lead oxide or zinc oxide or hydroxides of thin metals, suspended in the juice. The employment of saccharate of lead for the latter purpose is especially recommended.

*CHICAGO INSTITUTE MEETING.*—The Chicago branch of the American Institute of Electrical Engineers announces a "Telephone" meeting for February 16, 1904, at the usual time and place, 1741 Monadnock Block, at 8 P. M. This meeting was postponed from February 2, the date first announced. The general subject of the meeting will be the "Automatic Telephone Exchange." Two papers will be read and discussed at that time. The "Economics of the Automatic Telephone Exchange," by F. J. Dommerque, and "Two Methods of Giving Toll Service with Automatic Exchanges," by Charles S. Winston.

*GREAT FIRE AT BALTIMORE.*—On Sunday, February 7, the city of Baltimore was devastated by a fire which continued burning 48 hours and destroyed property to the estimated value of $150,000,000 to $200,000,000. The fire began in a wholesale dry goods store and is reported to be due to the explosion of gasoline kept in a tank and employed to run an engine. Very few details are obtainable as we go to press, but it would appear that the Western Union, Bell Telephone, Postal Telegraph and United Light & Power and Railway systems have suffered very severely. Some of the plants have been wiped out or wholly destroyed, and there has been an urgent call for new apparatus.

*CONSTRUCTION OF PLANTÉ PLATES.*—A patent granted on February 2 to Mr. Joseph Bijur, of New York City, who has been active in recent years in developing a new form of storage battery, relates to the mechanical construction of the plates. His battery is of the Planté type, very minutely divided strips, shelves or shreds of lead (afterwards to undergo a process of formation) being autogenously united with lead or lead-antimony supports. His present patent relates to the arrangement of the strips in such a way as to insure that the crowding effect of the layer of active material produced afterwards during formation does not lessen the strength of the plate.

*TRAMPS AND TELEPHONES.*—One of the many benefits of the use of the telephone in rural districts is the check upon the lawless tramp. In one county in Indiana the tramp nuisance has been largely mitigated by the prompt enlistment of the Sheriff's aid by telephone. Out there it is the belief that where there are telephones tramps cannot abide.

*RADIUM IN MONOPOLY.*—The *Matin* and other Paris newspapers are loud in demanding that radium remain a specific French article, which all the world shall buy here. "Radium," say the papers, "is a French discovery, and we would be foolish to allow other nations to profit by the genius of our scientific men." At the same time Austria is being savagely attacked "for keeping up the price of the raw material"—in order to protect her Bohemian glass industry.

*N. E. L. A. ANNUAL VOLUME.*—The National Electric Light Association has just issued its volume of transactions containing the full report of the Chicago convention of 1903. It is a superb record in every way and reflects great credit upon all concerned. It embodies, moreover, a great deal of valuable matter in the shape of papers, discussions, reports, answers to questions, etc. The main part of the volume embracing the report proper runs a length of 538 pages, but there is a huge appendix inclusive of two or three appendices making at least another 300 pages. The members of the Association, if they got nothing else, might well rest satisfied with this evidence of the Association's activity and influence.

*NATIONAL ELECTRICAL CONTRACTORS.*—The National Electrical Contractors of the United States held their quarterly meeting at the New Willard Hotel in Washington, D. C., on February 1. After the morning session the delegates were entertained at luncheon by the local members of the Association. During the day they visited the White House and were presented to President Roosevelt. Mr. E. McCleary, of Detroit, president of the Association, made a short address, which was responded to by President Roosevelt in a very happy speech. The members expressed themselves as highly pleased with their reception. There was a good attendance at the meeting. The annual meeting will be held at St. Louis on September 13, 14, 15 and 16 next.

*HARDENING ALUMINUM.*—Since the commercial introduction of aluminum an important problem has been the discovery of means for hardening the material so that it might enter into uses which the softness of the pure metal precludes. It is claimed that a discovery of such a means has recently been made by W. Rubel, of Germany, the process of hardening being a chemical one. The new metal is called "meteorit" and is claimed to retain all the good qualities of pure aluminum and possess important new ones. The specific gravity is practically equal to that of aluminum; the metal is not affected by acids, the atmosphere or sea water; it can be cast like iron, has 8 per cent. greater tensile strength than cast iron, and can be recast without losing its qualities. It can be rolled cold and does not become brittle when hot; it has nearly the conductivity of copper, will keep a high polish, and can be plated. We understand that the American patents for this new metal are now being offered for sale.

*TROUBLE IN KOREA.*—On January 24 the United States State Department at Washington received official information of an attack by a mob of native Koreans on an electric car because it had killed a Korean. The news came in the following cablegram received from Minister Allen at Seoul: "This morning on the electric railway, which is the property of American citizens, a Korean was accidentally and unavoidably killed. Thereupon a mob of natives attacked and partially destroyed the car. The operators of the car would have been injured had it not been for the presence of mind and action of our guard, and a serious riot would have occurred." Although there have been previous reports of disturbances in Korea, this is the first mob attack made on the property of Americans. The railroad is owned and operated by Americans, H. R. Bostwick, of San Francisco, and H. Collbran being its principal officers. It runs through the heart of Seoul. The United States Legation guard now consists of 100 marines. The reinforcement of this guard has been urged, and could be effected in a week's time by details of marines from the Philippines.

# LETTERS TO THE EDITORS.

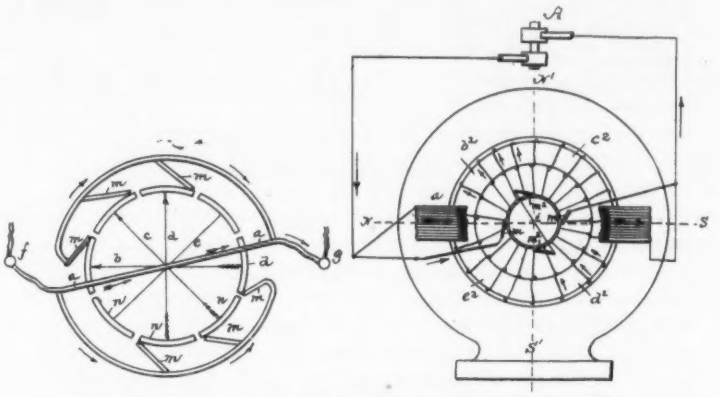
## Invention of the Alternating Current Commutating Motor.

*To the Editors of Electrical World and Engineer:*

SIRS:—I have read with much interest in your issue of January 16 the note in the Digest (page 143) in regard to the controversy between Mr. Latour and Messrs. Eichberg and Winter regarding the priority of invention of the motor in question. The interest aroused in this subject will perhaps justify a suggestion from me as to the solution of the puzzle, "who is the original inventor?"

As there has been much work done in alternating-current commutating motors in the past decade, I had the suspicion that the fundamental principle of compensation applied in different ways in the Latour and Eichberg-Winter motors, was embodied in some other machine before. My suspicions were confirmed by finding United States Patent No. 476,346, filed on November 14, 1888, by Mr. M. J. Wightman and granted in June, 1892, which describes and illustrates fully the actual Latour compensated motor, not only in principle, but in construction.

The drawing and the principal points of this patent are sufficient to demonstrate that the inventor in 1888 was guided to study and



WIGHTMAN ALTERNATING-CURRENT COMMUTATING MOTOR.

propose his motor by the same motive that guided M. Latour in 1902. To quote from the specifications: " . . . . . a successful alternating-current motor must have very little self-induction. The difficulty in using an ordinary series or shunt motor for alternating current comes from this cause. . . . . An alternating-current motor consisting of a closed circuit armature having opposite commutator brushes maintained in position approximately ninety degrees from the main brushes and connected directly with one another, said main brushes being connected to a source of alternating current, etc. . . . . "

Further comments are unnecessary, but it may be added that for the second time in recent years an old compensated alternating-current motor (or motor provided with means for diminishing the self-induction of the armature) is successfully resuscitated by virtue of the improved construction of electrical machinery. This was the case with the George-Heyland and now with the Wightman-Latour-Winter-Eichberg motors. The conclusion is that a study of the patents records is to be recommended to inventors in place of text-books.

CHICAGO, ILL. VICTOR MARTINETTO.

[The specifications of the Wightman motor refers to the patent of Elihu Thomson of May 17, 1887, on the repulsion motor, and state that, while the principle of the repulsion motor is utilized, "the alternating current in both field magnet coil and armature are both directly derived from an external source of current, which current is led through the two members in such direction that the synchronous alternations will each cause repulsion between them. The source may be of any desired nature—as, for instance, an alternating dynamo or a transformer. In practice, the best results are obtained by connecting the field magnet coil and armature in multiple to the alternating-current wire leading from the source. A simple form of motor embodying the invention would consist of an armature and field magnet such as shown in the [Thomson] patent before referred to, the connections to the open-circuited coils of the armature being made such that as they successively come into circuit

with the source they will carry alternating currents from the same, each of which will be in opposite direction to the simultaneously-flowing alternating current in the field magnet coil. . . . The principle of my motor is to cut out of action those portions of the motor which have great self-inducion. This can only be done by utilizing the repulsive effect and throwing away the attraction or using its self-inductive effect to take coils out of circuit." The essential point of the four claims of the patent is, as stated in claim 3, "a commutator by which the armature coils in one-half of the magnetic field or fields are cut out of circuit, the coils in the remaining half being alone used for producing the motive power."—EDS.]

## Distribution of Gas Power.

*To the Editors of Electrical World and Engineer:*

SIRS:—In view of the fact that large gas engines are now practical as prime-movers, the thought suggests itself that gas could be used to distribute power over large areas.

Take, for instance, a large urban railway system, it seems possible that instead of having one or more large central stations delivering high-tension alternating currents to rotary sub-stations, that a large gas plant could be used which could be connected by pipe lines to sub-stations, these sub-stations to contain gas engines running generators feeding the lines as at present.

It seems that a plant of this description would have advantages over the present system, namely, immunity from break-down, to which the present high-voltage distribution systems are liable, since the primary distribution of energy would be made by pipes laid underground. The gas plant would also produce by-products which could be disposed of at a profit, and there would be a saving in fuel costs on account of the higher efficiency of energy transformation in the prime-movers, etc.

ST. LOUIS, MO. J. D. EDWARDS, JR.

[A number of patents have been issued to Mr. George Westinghouse on systems of gas distribution in connection with electrical generation. Among the patents are one or more relating to electric traction work which cover the automatic starting and stopping of gas engine sub-station plants through contacts made by an electric car approaching or receding from the block served by the plant.—EDS.]

# DIGEST
## OF
## CURRENT ELECTRICAL LITERATURE.

### DYNAMOS, MOTORS AND TRANSFORMERS.

*Tandem Connection of Induction Motors.*—DANIELSON.—An illustrated article on the use of induction motors in rolling mills and in iron works in general. In a large Swedish iron works induction motors are used throughout, most of them being of the ordinary type, so that their speed cannot be easily varied. One motor, however, is used which, without losses in a rheostat, can be operated at the nearly synchronous speeds of 428, 375 and 333 r.p.m. The machine consists of a combination of two motors; the main motor, which is an ordinary 14-pole induction motor, and an auxiliary

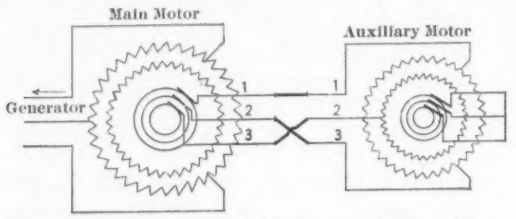



FIG. 1.—TANDEM CONNECTION OF INDUCTION MOTORS.

motor, which can be operated as well as a two-pole or as a four-pole motor. To get a speed of 428 revolutions the main motor is operated alone, while the auxiliary motor is without current. To get 375 revolutions, the auxiliary motor is connected so as to act as a two-pole motor and is connected in tandem with the main motor. To get 333 revolutions, the auxiliary motor is connected so as to act as a four-pole motor and is connected in tandem with the main motor. The power is always 150 hp. At 333, 375 and 428 revolutions and full load the efficiency is 87, 88 and 89 per cent. and the power factor 81, 83 and 92 per cent. It is necessary to design the

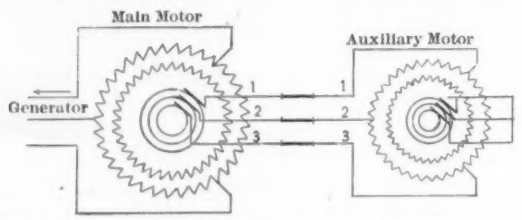



FIG. 2.—TANDEM CONNECTION OF INDUCTION MOTORS.

auxiliary motor so that the leakage is very small and the magnetizing current is also small. In the above motor only the direct tandem connection is used. If one would also apply the so-called differential tandem connection it would be possible to get with the same motor two other speeds, namely 500 and 600 r.p.m. It would only be necessary to provide the rotor of the auxiliary motor with slip rings. The author finally discusses the following three possible tandem connections between a main motor and an auxiliary motor. Fig. 1 shows the direct tandem connection; Fig. 2 shows the differential tandem connection in which the main motor is connected to the supply network, while Fig. 3 shows the differential tandem connection in which the auxiliary motor is connected to the supply network. The arrangement of Fig. 2 gives a better efficiency than that of Fig. 3, but in Fig. 2 the motor does not run up by itself to the desired speed while it does so in Fig. 3.—*Elek. Zeit.*, January 21.

*Leakage Factor of Induction Motors.*—BRESLAUER, ZOROWSKI, HOBART, BEHREND.—In his book on the induction motor, Behrend had given the following formula for the leakage factor: It equals a constant multiplied by the ratio of the radial depth of the air-gap to the polar pitch. This "constant" varies, however, somewhat for different conditions of design. In a recent paper of Hobart (ELECTRICAL WORLD AND ENGINEER, January 25), the variation of this "constant" was discussed in detail and curves were given for the same for completely closed and for wide open slots, with varying

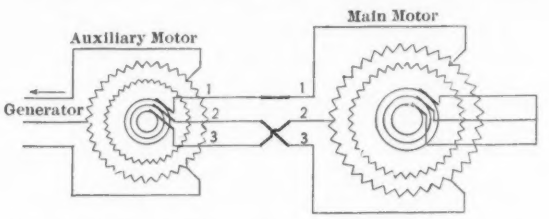



FIG. 3.—TANDEM CONNECTION OF INDUCTION MOTORS.

ratio of the radial depth of air-gap to the polar pitch at air-gap. In connection with this paper of Hobart, which was also published in *Elek. Zeit.*, a discussion of Behrend's formula has been started in the correspondence columns of the latter journal. Breslauer attacks the assumption that by increasing the radial depth of the air-gap, the leakage factor should always become worse. He refers to former researches in which he has shown that if the air-gap is increased, the magnetizing current must correspondingly increase, while the short-circuit current does not remain constant, but also increases to a certain degree. Under certain conditions the increase of the short-circuit current may be even greater than that of the magnetizing current, so that with an increased air-gap the overload capacity and the maximum power factor may be increased. If the rotor is fully removed he has found that the short-circuit current generally increases by 30 or 40 per cent. He thinks that Behrend's formula should be used with caution, since it supposes that the short-

circuit current remains constant with varying air-gap.—*Elek. Zeit.*, November 26. Zorowski agrees with Hobart that the use of too great a rotor diameter is a mistake, but he denies that the reason is that the power factor would be too small; he thinks the reason is based on considerations of economical design. He claims that Hobart exaggerates the influence of the "free" winding on the leakage, and that the poor power factor (0.83) in Hobart's example is due to bad design. For the predetermination of the leakage factor of induction motors he has found Niethammer's method to be the most exact one, in which the magnetic reluctances of all leakage fields are calculated.—*Elek. Zeit.*, December 3. Hobart replies to Zorowski that the motor given by him as example was not as an example to show; that the diameter was much too large and the length much too small, and that a better power factor would have been produced if the dimensions had been correspondingly changed. He thinks that Zorowski and many other designers underestimate the influence of the "free" length upon the leakage.—*Elek. Zeit.*, January 7. Behrend replies to Breslauer that the latter's experiments (which showed that the magnetizing current increased with increasing air-gap) were made with a motor with closed slots and the air-gap was increased, the iron cross-section in the bridges at the sides of the slots was also decreased and the magnetic reluctance of the field of self-induction was increased. It is self-evident that under such conditions the short-circuit current must become greater. But this is a case which is of no practical importance and which is not intended to be covered by his formula. What is of importance is to know how the short-circuit current varies, if the air-gap is changed, without changing the form of the slots and the thickness of the bridges. His formula was based on experiments with rotors of different diameter, but of the usual form of slots. He has now repeated these tests and has corroborated his old results. He has found that Breslauer is wrong in stating that the short-circuit current is greater with the rotor removed than under normal conditions. He has tested all new types of induction motors designed by him and has found that the stator consumes about the same short-circuit current when the rotor is removed or when it is in place. The differences in the current depend much more on the type of winding than on the fact that the rotor may be removed.—*Elek. Zeit.*, January 21.

*Single-Phase Motor.*—SCHÜLER AND MÜLLER.—Two communications criticising the single-phase motor of Corsepius recently noticed in the Digest. Schüler remarks that the motor is really no single-phase motor, but a two-phase motor in combination with a single-phase-two-phase converter. It has long been known that an ordinary single-phase motor can be used for changing single-phase into polyphase current. While Corsepius' motor is theoretically interesting, it has too great practical disadvantages, being expensive and having a poor power factor. From the figures given by Corsepius his motor has a power factor of 0.56 at full load, which may, however, be partly due to the imperfect design of the experimental motor. There is at present a practical need for single-phase motors with a great starting torque and also for single-phase motors which start with a slight torque and a very small starting current (larger motors in connection with lighting systems). For both applications he believes the commutator motors to be very suitable. He does not think that Corsepius' motor can compete with the latter. It is now possible to build alternating-current commutator motors which, with regard to sparkless running of the brushes, can be compared with good direct-current motors. Müller also remarks that during starting period the auxiliary motor of Corsepius is nothing but a converter which supplies two-phase current to the main motor, so that the latter starts in the same way as a normal two-phase motor. The auxiliary motor must furnish during this time the whole energy for the second phase and can, therefore, not be too small if it shall not be heated too much or fall out of stop.—*Elek. Zeit.*, January 21.

REFERENCES.

*Non-Synchronous Single-Phase Motor.*—EICHBERG.—A communication, in reply to Görges, on the theory of the single-phase motor, and especially on the "cross field." This has here another function than in the direct-current motor, in which the cross field may be diminished without diminishing the action of the motor. On the other hand, in the single-phase motor the cross field which is produced is the real magnetic field, which, together with the ampere windings of the stator winding, produces the torque.—*Elek. Zeit.*, January 14.

*Diagram of the Induction Motor.*—HEYLAND.—Some theoretical and historical notes on the development of the circular diagram of the induction motor. He says that what is now called the Ossana diagram was already given by him in his first publication on this subject.—*Elek. Zeit.*, January 21.

## LIGHTS AND LIGHTING.

*Incandescent Lamp of High Economy.*—BRESLAUER.—In a paper read before the Vienna Electrical Society he exhibited a new incandescent lamp patented by Just, which is claimed to represent an exceedingly important progress in electric lighting, since the lamp is claimed to use only half the current per candle than the carbon filament lamp. Such lamps have been built for 30 candles and 110 volts with a useful life of 250 to 300 hours and a consumption of 1.7 to 2 watts per candle. Two such lamps of 30 candles were exhibited by the speaker. The commercial manufacture of the new lamp, "the filaments of which are treated with an addition of boron nitride," is said to be neither more difficult nor more expensive than that of carbon filament incandescent lamps. To a question whether lamps for 16 candles and 110 volts have been made he replied that the manufacturers have not yet succeeded in doing so, but they hope to be able to build this normal type in the near future. The manufacture of 16-candle lamps for voltages up to 50 volts is, however, already possible.—*Elek. Zeit.*, January 21.

*Osmium Lamp.*—LOMBARDI.—An account of an investigation in which he measured the temperature of the filament of the osmium lamp by the same method which Weber had applied for the investigation of the carbon incandescent lamp. He first gives a summary of Weber's theory. Weber had found that the temperatures corresponding to the normal brightness of a great many different carbon filament lamps were all in the interval between an absolute temperature of 1565° and 1586°. Only for lamps with very strong brightness, or for lamps with thick filaments, which can be operated without disadvantage at higher temperatures and with greater economy, the normal temperature was found about 40° higher. The present author concludes from analogous measurements with the osmium lamp that the temperature of its filament at normal brightness is about 1435° (apparently meaning absolute temperature, which would correspond to 1162° C.), this is about 135° less than the normal temperature of the carbon filaments of ordinary incandescent lamps. To explain that nevertheless the economy of the osmium lamp is much better than that of the carbon filament lamp he takes recourse to Weber's theory, according to which the economy of an incandescent lamp depends upon two independent quantities, namely, the absolute temperature and a characteristic value, called by him the "illuminating capacity" (Leuchtvermögen). If operated at an equal temperature between 1400° and 1500° absolute temperature, he concludes that the osmium lamp would have an economy 9.1 to 12.5 times better than that of the carbon filament lamp. He considers his measurements with the osmium lamp to be an excellent confirmation of Weber's theory. The main result of practical importance is that the considerable improvement of economy, observed with the osmium lamp, is not due to an increase of temperature, but exclusively to the considerable difference between the "illuminating capacity" of osmium and carbon. It is, therefore, not impossible that other substances which are much cheaper and have a high melting point and are more rigid at high temperature can be used for the manufacture of incandescent lamps.—*Elek. Zeit.*, January 21.

*Incandescent Gas Light and Electric Arc Light.*—A note stating that an official report of Seggel and Eversbusch concerning the best lighting system for the Bavarian public schools had been in favor of incandescent gas light. To counteract this the Schuckert Company had presented another report by Lehmann-Richter, giving the results of comparative tests with two arc lamps or 14 gas incandescent lamps in a school room. The illumination was good in both cases and sufficiently uniform. The electric light did not deteriorate the air nor increase the temperature considerably. With gas incandescent light the temperature at the height of the pupils' eyes was increased in three hours about six degrees, while the carbonic acid contents of the air was increased five times. This is thought to be more than permissible for sanitary reasons. The cost of operation of the Welsbach lights is smaller than that of the arc light in the beginning, but after a short use the cost of operation of the Welsbach mantles becomes as high as that of the arc light.—*Elek. Zeit.*, January 21.

REFERENCES.

*Electric Arc.*—SCHULZE.—An account of an experimental investigation on the electric arc between metal electrodes or between a metal and a carbon electrode, and especially on the voltage loss in the arc. To explain his results the author brings forward the hypothesis that such quantities of electricity, as used in lighting currents, can go over from a solid body or from a liquid into a gas only in connection with molecules of the solid body or the liquid; that is, only under the condition that the latter body evaporates.—*Ann. d. Phys.*, Vol. 12, 1903, page 828; abstracted in *Elek. Zeit.*, January 21.

*Electric Arc.*—STARK.—An account of an investigation in which the author endeavors to elaborate the view that in the electric arc positive and negative ions are the carriers of the electric current. One of his principal assumptions is that in the arc light the "negative electron ions are obtained from the cathode itself, not by ionization, but by electrification." The cause of the emanation is the high temperature of the cathode.—*Ann. d. Phys.*, Vol. 12, 1903, page 673; abstracted in *Elek. Zeit.*, January 21.

## POWER.

*Thury High-Tension, Direct-Current Power Transmission.*—In a description in the Lond. *Electrician* of the power transmission between St. Maurice and Lausanne, the opinion had been expressed that a transmission on the series direct-current system is "hopelessly out of date." The Compagnie de l'Industrie Electrique, which had installed this transmission, contradicts vigorously and refers to the experience at Lausanne (where the very peculiar combination of the Thury system for transmission to the city with three-phase transmission within the city is used). It is stated that since the day of putting the installation into service, in July, 1902, until now the high-tension, direct-current transmission "has not been interrupted one hour for reasons of failure of the electric plant, while the secondary distribution, which is carried out with alternating currents at a pressure of 3,000 volts only, has had to be stopped several times on account of failures of the transformers or of the line." It appears that the Thury system is considered especially suitable for large power transmissions and for long distances.—Lond. *Elec.*, January 22.

*Power in Mines.*—CAMERON.—An illustrated article on the use of electric power in an oil mine in the Lothian district in Scotland. Three-phase induction motors are used for breaking, hauling, pumping, etc. Their great reliability is emphasized and it is mentioned that a 30-hp induction motor is employed to drive gas-exhausters in the distillation plant, and has been running for six months without a single stoppage, and for most of this time, without stand-by power. Any stoppage for a moment of these exhaust fans would be extremely serious, since the gases would rush back into the retorts and cause an explosion. For traction two locomotives are used, supplied with 500 volts direct current from a trolley wire. The results of the introduction of electric power have been a great reduction in coal consumption, as compared with many mines in the neighborhood; economy in labor, since the induction motors practically do not need attention; greater elasticity, cleanliness and convenience.—Lond. *Elec. Rev.*, January 8.

REFERENCES.

*Drilling and Riveting Machinery.*—PERKINS.—A fully illustrated article on portable electric drilling and riveting machines for use in shipyards. He distinguishes the following three types: Those operated by electric motors without electromagnetic devices for holding drills to plates; those with such electromagnetic devices, and electro-pneumatic drills and riveters which use electricity only to hold the machine against the plate to be riveted.—*Cassier's Mag.*, February.

*Water Power Plant in Greece.*—GUARINI.—An illustrated article on the first hydroelectric plant of Greece, at the foot of the mountain of the Muses. There are two 130-kw, 5,000-volt, three-phase alternators mainly for use in connection with a pumping station.—*Eng. Mag.*, February.

## TRACTION.

*Surface Contact System.*—A description of the "G. B." surface contact system, which is being used on an experimental line in England. The bare conductor, consisting of stranded galvanized iron cable, is drawn through plain stoneware pipes, and is suspended at convenient intervals by vitrified clay insulators. Every 7 ft. 6 in., corresponding to the distance between studs, a short vertical earthenware tube is cemented to the main horizontal pipe, as shown in Fig. 4. Into this vertical portion of the pipe system the laminated stalk of the stud is let, the upper portion of the intervening space between it and the tube being subsequently filled up with bitumen, a packing of jute yarn preventing this material from falling through.

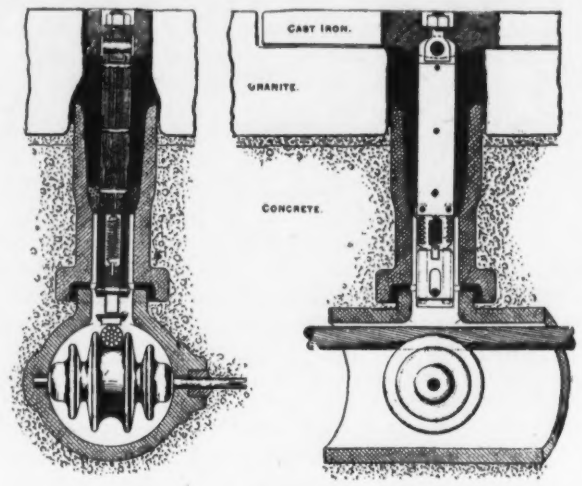



FIG. 4.—SECTIONS OF STUD.

A loosely fitting contact plunger, consisting of a laminated body and a carbon contact piece, slides in the brass-lined fork of the stalk. It is electrically connected to the stalk by flexible copper conductors and is held up from the cable against the force of gravity by an insulated phosphor-bronze spring. The stalk is connected to the cast-iron stud by a somewhat flexible joint, but this does not prevent it from making good electrical and magnetic contact. A recessed granite block receives the stud, which is level with the track. Each car is provided with a magnet rigidly suspended beneath the car and a battery of accumulators which serves for starting only, being charged during ordinary running. One pole of the magnet is in the form of two parallel iron bars, suspended at a distance of about two inches above the center of the track. Between these two bars are a number of iron tongues, suspended by

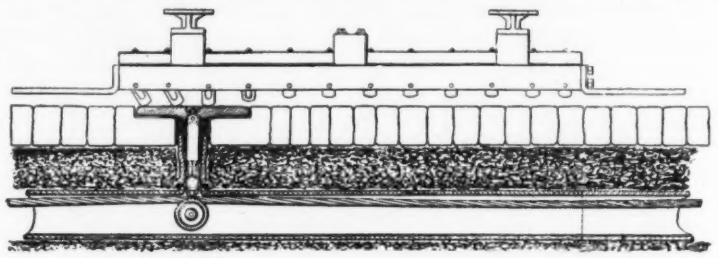


FIG. 5.—CURRENT-COLLECTING DEVICE.

springs, but free to move a considerable distance up and down. These are all connected at their lower ends by one flat chain belt, about 5/8 in. wide, which is kept parallel to the track at a distance of approximately 3/8 in. by the springs and tongues referred to. In order to have a continuous supply of current, the belt is made longer than the distance between any two studs. As the car comes over each stud, both the flexible chain belt and the sliding plunger are attracted downwards, and the former, on coming in contact with the stud, completes the electric circuit. In case the stud should remain alive after the chain belt has passed it, the supply is interrupted by means of chains fixed to the end of the car and trailing on the track, coming in contact with the live stud and causing a maximum cut-out on the car to operate.—Lond. *Elec.*, January 8.

*Electric Traction on Trunk Railroads.*—VANDEVILLE.—An article the greatest part of which deals with a comparison between the following two Italian electric railways: The Lecco-Sondrio-Colico & Chiavenna road (105.4 km, three-phase transmission, at 20,000 volts to transformers along the line, which reduce the voltage to 3,000, at which pressure three-phase motors on the trains are supplied), and the Milan-Porte Ceresio road (73.02 km. three-phase transmission at 12,000 volts to converter sub-stations, the trains being supplied with 650-volt, direct-current from a third rail). Both railways are in commercial operation. The author concludes that the only advantage of alternating-current traction is the use of high voltage for long-distance lines. However, a direct-current system

can also be used over a comparatively long line, if a series system is used. The motors may easily be constructed for 1,000 volts, and by using four motors on a car, couple in pairs of two in series, a voltage of 2,000 may be used on the line. He, therefore, thinks that the superiority of the alternating current begins only when a voltage of 3,000 to 10,000 is to be used.—*L'Eclairage Elec.*, January 23.

REFERENCE.

*Electric Traction on Trunk Railways.*—BONNIN.—The first part of an article in which the author gives considerations on the future of electric traction on trunk railroads. In order to use the present railway cars, it will be necessary to employ electric locomotives, and the problem resolves itself into two questions: that of the cost and that of the system of current to be employed. The author begins to discuss the second question, but does not reach a decisive result in the present installment.—*La Revue Tech.*, January 10.

## INSTALLATIONS, SYSTEMS AND APPLIANCES.

*Cologne Station and Double Tariff.*—OVERMANN.—A paper read before the Cologne Electrical Society. The city has now two electric stations. The one plant contains four 500-kw machines, the second station four 1,000-kw machines. The ratio of the sold kilowatt-hours to the available kilowatt-hours was 15.5 per cent., 24.5 per cent., in 1900, 1901 and 1902, respectively. It is thus seen that the load factor has only recently been increased, due to a lower rate for electrical energy. Data are given on the financial results during the last seven years, and it is shown that even if only a small profit is made per kilowatt-hour a considerable increase in the sale of electrical energy produces good financial returns in general. There is now used a double tariff, according to the time at which the energy is used. During the time of reduced rate 5 cents is charged per kilowatt-hour for use up to 1,000 kw-hours; for 1,000 to 2,000 kw-hours the first 1,000 kw-hours are charged $50 for and every further kilowatt-hour 4.5 cents, etc.; for more than 20,000 kw-hours the first 20,000 kw-hours are charged $690 and every further kilowatt-hour 2½ cents. During the hours of the higher tariff 12½ cents are charged per kw-hour up to 1,000 kw-hours. For 1,000 to 2,000 kw-hours the first 1,000 kw-hours are charged $125 and every further kilowatt-hour 11¼ cents, etc.; for more than 40,000 kw-hours the first 40,000 kw-hours are charged $2,850 and every further kilowatt-hour 3¾ cents. The time of the higher tariff is in January, between 4.30 P.M. and 9 P.M.; in February, 5.30 to 9.00; in March, 6.30 to 9.00; in April, 7.30 to 10.00; in May, 8.00 to 10.00; in August, 7.30 to 10.00; in September, 6.30 to 10.00; in October, 5.30 to 9.00; in November, 4.30 to 9.00; in December, 4.00 to 9.00. At all other times the reduced rate is charged so that during June and July this lower rate is always charged. No difference is made whether the energy is used for lighting or power purposes.—*Elek. Zeit.*, January 21.

*Stepney.*—An illustrated description of the Stepney Borough Council electricity works, which is worked in conjunction with a refuse

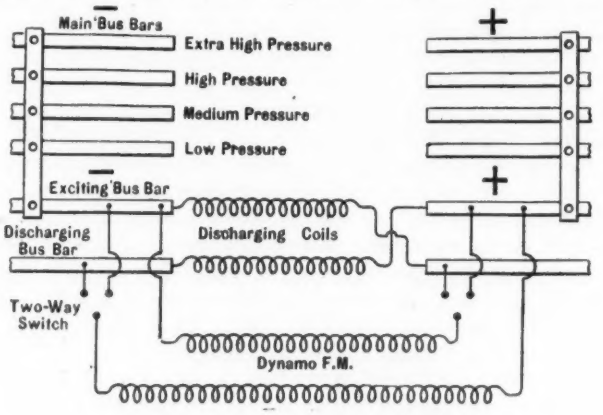



FIG. 6.—DIAGRAM OF CONNECTIONS.

destructor which, however, can furnish only a limited amount of steam. The plant contains four 275-kw and one 500-kw dynamos. The arrangement of the switchboard is interesting and is shown in Fig. 6. The positive and negative panels are each provided with four main bus-bars. By means of short bars at right angles to these, and suitable plugs and sockets, any feeder can be plugged on to any bus-bar. Similarly, separate bus-bars may be employed for separate generators, or they may all be plugged together. This arrangement permits of feeders which supply distant points being raised to a higher potential than those supplying points close to the station. The dynamo and feeder cables are so arranged as never to come into contact. There are two smaller bus-bars below the main bus-bars, the top one supplying the exciting current, and the lower one being called the "discharge bar." Instead of employing a separate coil for each dynamo for damping the rises of potential due to self-induction obtained when breaking the field, only two coils are used for all machines in the station. According to the direction in which the fields are wound, they are connected up as shown in the diagram, and the result is a considerable simplification and reduction in the number of switchboard connections.—Lond. *Elec.*, January 8.

*Frankfort Electric Station.*—An abstract of the official report of the Frankfort electric works. There are two stations. In the first a new 5,000-hp steam turbine has been installed which has been found to be absolutely reliable. Although built for 2,600 kw, single-phase current it is able to give up to 3,200 kw. The whole station contains four steam dynamos each of 552 kw, four steam dynamos each of 1,033 kw, and one turbo-generator of 3,200 kw. The consumption of fuel per generated kilowatt-hour was 1.63 kg. (3.6 pounds), against 1.72 kg. in the preceding year. There were generated in 1902 15,773,781 kw-hours. The house connections aggregate 16,110 kw, which is equivalent to 322,200 incandescent lamps of 16 candles. The second plant has a capacity of 402 kw direct current and 1,000 kw, three-phase current.—*Elek. Zeit.*, January 7.

*Liquid Rheostats.*—NIETHAMMER.—Some theoretical considerations on the design of liquid rheostats. There are two types. In the first the liquid in the containing box is constant and the electrodes are movable; in the second the electrodes are stationary and the quantity of liquid is changed. The author gives some numerical data on the resistance of various electrolytes, suitable for this purpose, and then shows theoretically that one should distinguish between liquid rheostats used only for a short time (for instance, for starting) and those which are in circuit for a longer period. For the former one should endeavor to use a large quantity of liquid with a small surface, which for the latter case a small quantity of liquid with a large surface is preferable. In the latter case the surface should be corrugated or a containing vessel of ring form should be used.—*Zeit. f. Elek.* (Vienna), January 17.

## ELECTRO-CHEMISTRY AND BATTERIES.

*Permanent Magnets.*—WEICHSEL AND HIECKE.—Two communications referring to a recent discussion by Emde whether a permanent magnet is to be considered as the seat of a certain number of lines of force or of a certain m.m.f. In opposition to Emde, Weichsel arrives at the result that the m.m.f. of a permanent steel magnet is to be considered constant. He gives some theoretical considerations to prove that we must assume that when the magnetic reluctance is increased, a permanent magnet gives off energy in some form, perhaps heat. Hiecke criticises some theoretical suppositions of Emde and Busch. He agrees with the latter that in producing a permanent magnet, the magnetism becomes the stronger, the smaller the reluctance in the air-gap in the magnetic circuit, other things being equal. He has found that permanent magnets for a registering instrument when magnetized with the pole shoes (which considerably decrease the magnetic reluctance) obtained a much higher magnetism than when magnetized without these pole shoes. Concerning Emde's fundamental question mentioned above, he claims that practically constant properties can be found in permanent magnets only if they are subjected to no or very small external magnetic influences. In this case the number and direction of the lines of force and the m.m.f. are constant. If, however, a strongly magnetized body is approached to the magnet, the number and direction of the lines of force is changed. This change will be instantaneous if the movements of the molecules inside the magnet can go on within the elasticity limit. If, however, a further external impetus is necessary, in form of a very strong movement of the molecule or of a long series of preceding changes of positions of other molecules, the changes of the lines of force in the permanent magnet will require time. A well-known example for this phenomena is a gradual increase of the tractive forces of a magnet to the poles of which an armature has been attached.—*Elek. Zeit.*, January 14.

*Rotation of Lines of Force.*—DUESING.—Hoppe had investigated whether the lines of force of a magnet revolve with it, and has found that they do so, since they show a slight drag in the direction of

rotation. The present author has investigated the further question as to whether the lines of force revolve with a rotating armature when the magnets remain fixed, and also found a slight drag in this case. He laid a flat iron ring between the poles of a permanent magnet, covered it with paper and dusted iron filings upon it. With a proper field strength he obtained a slight tracing of the lines of force within the ring, in spite of its shielding action. He then substituted a piece of photographic paper for the ordinary paper, and made the ring revolve about its own axis. The tracing of the lines of force obtained during the rotation was fixed by holding a lighted match over the paper. The tracing showed a distinct but slight inclination of the lines of force both within the ring and outside of it in the direction of rotation. The ring must, therefore, have dragged the lines of force with it to some extent.—*Ann. d. Phys.*, 1903, No. 13; abstracted in Lond. *Elec.*, January 22.

REFERENCE.

*Magnetic Fields of Coils.*—Koenig.—An article in which the author shows how to determine, with the aid of diagrams, the field in any point near a coil without iron core through which a current passes.—*Elek. Anz.*, January 14, 21.

### Electro-Chemistry and Batteries.

*Soldering Aluminum.*—An anonymous communication in which the following composition of a solder for aluminum is given: 10 parts bismuth, 30 parts zinc, 60 parts pure tin. The bismuth and zinc are first melted and the tin is then added; the whole is poured into molds about a foot long and about the size of a pencil. To do the soldering the writer uses a stick of solder, an old nickel aluminum spoke and a blow torch. The pieces to be soldered are held in a vise or any convenient place, the flame is applied from the torch until they are hot enough to melt the solder, when it is applied, then the surface to be soldered is scraped with a file or scraper. The solder is melted on to each piece and worked around with the spoke; the parts are then held together in front of the flame and the torch is removed.—*Am. Mach.*, January 7.

*Dielectric Constants of Solvents and Solutions.*—Eggers.—An account of an experimental investigation in which he measured the dielectric constants of various hitherto uninvestigated solvents, notably sulphur compounds. It is shown, notably in the case of the nitriles, that the dielectric constant is not an additive property, but depends to a very great degree on the relative chemical structure of the molecule. In cases where several solvents were used with the same solute, the dielectric constants of the mixture did not indicate that the solute exerted a similar influence in each case. This points to the conclusion that the dielectric constant of a solution is not a simple function of either constituent, but is due to an indefinite compound, i. e., a compound acording to variable proportions, resulting from combination of the constituents.—*Jour. Phys. Chem.*, January.

REFERENCE.

*Nickel and Copper Analysis.*—Browne.—An illustrated description of an automatic device for the use of a storage battery and an incandescent light circuit for nickel and copper analysis. The current is so divided as to furnish a steady flow to the nickel plating and half as much to the copper plating frames.—*Electrochem. Ind.*, January.

### Units, Measurements and Instruments.

*Wehnelt Interrupter.*—Van Dam.—An article in which he refers to Zehnder's simplified form of the Wehnelt interrupter. The author describes a further simplification. The difficulty of mounting the platinum pencil in such a manner that no liquid can pass it, is overcome by using india rubber instead of ebonite. As long as the current does not exceed 0.6 amp. per sq. mm., good Para rubber is consumed exceedingly slowly. The author has only once renewed the rubber in his apparatus within the last two years. The operation is of extreme simplicity. The brass rod with the soldered-in platinum wire can be placed directly in the glass tube without using an extra brass tube. Hard solder need not be used, since the joint does not come into contact with acid. The concussions are deadened by the rubber in such a manner that there is practically no danger of breakages. The author uses a tube of 8 mm. internal diameter, to one end of which another tube half that width and about 3 cm. long is fused. The brass rod with platinum wire 1 mm. thick is introduced into the glass tube, and a piece of tubing of the best Para rubber and less than 1 mm. in internal diameter is slipped over the projecting platinum wire. It is wetted with water and then pressed into the narrow tubing.—*Ann. d. Phys.*, No. 13, 1903; abstracted in Lond. *Elec.*, January 8.

*Measuring the Resistance of Highly Insulated Substances to Perforation.*—Walter.—A long reply to some criticisms brought forward against his method which was described in the Digest October 17. He denies that Holitscher (Digest, November 21) is justified in saying that the method depends too much upon the skill of the operator, He considers that the drop of wax used by him is an advantage because the irregularities of the surface of the material which are of such great importance are thus entirely excluded, and what is measured is the "internal" resistance to perforation. The needle electrodes he also considers an advantage, because with the use of plates as proposed by Holitscher the dielectric hysteresis heat is unnecessarily increased, so that thereby the real internal resistance to perforation is clouded by secondary phenomena. In practice, of course, the condition of the surface and the hysteresis heat are of importance, but these two factors ought to be tested by separate methods. He points out that by his method he has found the following three important general results on the internal resistance to perforation. First, glass containing lead has a considerable smaller resistance than ordinary glass. Second, hard rubber has a considerably smaller resistance if inorganic salts are added to it than without the same. Third, a hard rubber material can be made which has about three times the resistance of that of ordinary kinds of this material. Another criticism which had been made was that the resistance to perforation was formerly measured by the alternating-current voltage required for perforation while he measures it by the equivalent spark length of an induction apparatus between needle electrodes in air. He thinks this is the proper way since measurements of the alternating-current voltage do not give uniform results.—*Elek. Zeit.*, January 7.

REFERENCE.

*Influence of Wave Form on the Application of the Two-Wattmeter Method.*—Dina.—A criticism of a paper of Bloch recently noticed in the Digest. The present writer claims that Bloch's theory is wrong. He has formerly obtained the following results which are valid for any number of harmonics. The true power factor (determined from the power, the voltage and the current) is smaller than the cosine of the angle between the partial voltage and the partial current for the fundamental wave. The power factor determined by the tangent formula may be either greater or smaller than the cosine of the phase difference between the partial voltage and the partial current for the fundamental wave. The tangent formula gives a value of the power factor larger than the true one.—*Elek. Zeit.*, January 14.

### Telegraphy, Telephony and Signals.

*Telegraphone.*—Strecker.—A brief paper read before the Berlin Electrical Society. He exhibited some apparatus of the Danish and German telegraphone companies. As is well known, the telegraphone is a magnetic phonograph; the transmitted telephone currents pass through the winding of the small electromagnet, before the one pole of which a steel wire or a steel ribbon or a steel disc is rapidly moving. The varying magnetizations due to the telephone currents are impressed on the steel wire or disc. If afterwards the same ribbon or disc is passed before another small electromagnet of the same type, which is connected to a telephone, the original speech is reproduced at the telephone. In the exhibited apparatus either steel wire or discs were used. The wire apparatus has the advantage that it gives louder sounds, because it is possible to move the wire much more quickly. An apparatus with a length of wire of 6,000 meters is sufficient for a conversation of 40 minutes. They have used the apparatus successfully for transmission from Strasburg to Berlin and from Frankfort to Berlin. In another form of apparatus the telegraphone is used in connection with the ordinary telephone, for the use of cautious business men. When they have an important conversation they connect the telegraphone with the telephone and have the whole conversation taken down by the former. Another application is for replacing a stenographer; instead of dictating something to the stenographer, one speaks into the microphone and the whole speech is taken down by the telegraphone. The typewriter then takes the telegraphone and takes the dictation from the latter (as is now sometimes done with the phonograph). If the telegraphone speaks too quickly, she pushes a button and the telegraphone not only stops at once, but goes somewhat back and

repeats the last words. In the apparatus with a steel disc the latter rotates, while the electromagnet moves slowly in a radial direction towards the center of the disc. The conversation is, therefore, taken down in form of a spiral line. After a conversation has been impressed upon a steel disc, the latter may be sent by mail to the addressee, who can then hear the message by putting the disc in an identical telegraphone. Compared with the written letter, the "telegraphone letter" has the advantage that it reproduces not only the words but also accents, emphasis, etc.—*Elek. Zeit.*, January 7.

REFERENCES.

*Telephone Cables.*—SCHMIETT.—An illustrated article on the manufacture of telephone cables with several cores and air insulation.—*Zeit. f. Elek.* (Vienna), January 17.

*Localization of Breaks in Submarine Cables.*—DAVIDSON.—A brief mathematical article on the different formulas for determining the resistance from the testing station to a break.—Lond. *Elec. Rev.*, January 8.

MISCELLANEOUS.

*Cure of Cancer by Zinc Ions.*—LEDUC.—A description of a cure of a cancroid growth, which was in the right wing of the patient's nose, and had existed in a constant state of ulceration for five years. He applied to its whole surface a plug of hydrophil cotton impregnated with a one-per-cent. solution of zinc chloride. This was connected with a positive pole of a battery whose negative pole was connected with some part of the body through a large inert electrode. A current of eight milli-amperes was passed for 12 minutes without causing any pain, and boric vaseline was subsequently applied. The crusts detached themselves immediately, and ten days afterwards the ulcer was completely scarred over and of good aspect. Ten weeks afterwards the scar remained perfect, with the exception of a slight sore at the tip of the nose, which was treated similarly.—From *Arch. d'Elec. Med.*, December 15; in Lond. *Elec.*, January 8.

REFERENCES.

*Magneto Ignition.*—An illustrated description of the Albion system of magneto ignition for internal combustion engines. It consists generally of a magnetoelectric generator driven directly from the crank-shaft of the motor, generating the necessary current for the igniting spark. From the magneto current is led to make-and-break spark plugs of simple design fixed on the combustion chamber of each cylinder, the make-and-break being operated by a trip rod and cam mounted on the half-time shaft. The ring-shaped armature of the generator is bolted to the engine casing and the field magnets are mounted on a spider keyed to the crank-shaft. The device is described in detail and illustrated.—Lond. *Elec.*, January 8.

*Machine Tools.*—A fully illustrated article on special machine tools at the Corliss engine shops. With the exception of the frame milling machine, every tool is driven by vertical steel shafts.—*Iron Age*, February 4.

*Biographical.*—A biographical sketch, with portrait, of Lewis Buckley Stillwell, the electrical director of the Interborough Rapid Transit Company, of New York.—*Cassier's Mag.*, February.

## New Books.

ELEMENTS OF ELECTROMAGNETIC THEORY. By S. J. Burnett, Ph.D. New York: Macmillan Company. 473 pages, 145 illustrations. Price, $3.00.

The object of this book, as stated by the author in his very brief preface, is "to present in systematic and definite form a simple, rigorous and thoroughly modern introduction to the fundamental principles of electromagnetic theory, together with some of the simpler of their more interesting and important non-technical applications." This is a worthy object, but somewhat difficult of attainment. Several writers have attempted to simplify Maxwell and other authorities, but in some instances the simplification has been more difficult to grasp than the original. The union of profound mathematical powers with a faculty for logical and perspicuous writing is rare, and of a value commensurate with its rarety. The author of the present work is happy in many of his demonstrations; they are elaborated without the unnecessary use of mathematical symbols, the stumbling block of lower grade mathematicians, and while carrying conviction by rigorous reasoning, are not unnecessarily prolix. The mode of treatment of some other demonstrations may not be the best possible, but on the whole the book is extremely satisfactory in mathematical method.

In speaking of the "mechanical conception of the electric field," the author wisely remarks that "this conception" . . . "leads to results by no means wholly consistent." On the other hand, in dealing with the theory of the dimensions of units, the author shows a diminished power of resistance to the logical fallacies of the Rückerian philosophy. The remarks about the dimensions of permeability and capacity recall memories of the polemics upon the subject of "qualitative mathematics," published in that journal some years ago.

Mathematical treatises on electricity usually consider Green's theorem early in the book, but the present work omits it altogether. This is not objectionable in a work which, like this one, makes no attempt at exhaustive treatment of the subject, but confines itself to elementary matters. It is much better than to give an unsatisfactory treatment of the theorem, as is sometimes done. Anyone who has read Green's original paper knows that it is more lucid than some of the commentaries on it. There are other books intending to cover the same field, and although this one does not pretend to originality except in the mode of treatment, it has a *raison d'etre*.

THE ELASTICITY AND RESISTANCE OF THE MATERIALS OF ENGINEERING. By Wm. H. Burr. New York: John Wiley & Sons. 978 pages. Price, $7.50.

The present edition of this standard work constitutes almost a new book, one-half or more of the entire volume being new matter. The work as a whole is divided into two parts, analytical and technical. The former consists of five chapters treating the general theory of the subject under the following heads:

Theory of elasticity in amorphous solid bodies; hollow cylinders and spheres, and torsion, flexure, resilience, combined stress conditions. In the development of pure theory the standard methods are for the most part followed, though the author's individuality is often present in the discussion of special points. Taken as a whole, these five chapters furnish an excellent treatise on the general theory of the subject, developed to the extent likely to be needful for the purposes of the engineer.

Part II contains the results of theory applied to the problems of actual engineering construction, and contains most of the new matter in the present edition. It consists of fourteen chapters covering the following topics: Tension, compression, long columns, shearing and torsion, bending or flexure, concrete-steel members, flange beams, connections, plate girders, rope and chain cables, working stresses and factors of safety, miscellaneous problems, fatigue of metals, flow of solids. The chapter on "Concrete-Steel Construction" has received especial attention, and the author has endeavored to set forth here the treatment of concrete-steel beams and other members with sufficient fulness to meet the advancing requirements of this rapidly extending field of engineering construction. Throughout this section of the work the treatment is admirable in arrangement, ample in scope, clear in style and with a due admixture of experimental fact and general discussion. The treatment is especially full in the presentation of tabular matter giving the results of great numbers of tests and relating to all manner and form of constructive material. This section of the work is followed by an appendix of four chapters giving a more general and extended development of the theory of elasticity in amorphous solid bodies. It is not expected that the subject matter of this appendix will be of any great value to the general practitioner; nevertheless, every thorough student of the subject will need to be familiar with the generalized and fundamental treatment of the problems which it presents, and it is for such that the treatment of the appendix is intended.

A further appendix contains the tables and technical data furnished by the Cambria Steel Company, and published in their hand book on structural materials. This matter will be found of great practical value in structural practice, and at the same time is intended to add to the value of the work as a text-book for purposes of instruction, by facilitating the giving of extended practical exercises.

As a whole this work in its present amplified form takes a leading place in the world's literature of the subject. The name of its author carries justly the weight of long years of experience as an investigator, a teacher, and a successful practitioner and advisor. The present volume is one such as we might expect from the long distinguished professional career of its author, and as a general treatise on the subject it will long serve as a standard for use in class room and for daily reference on the part of the practical engineer. Both author and publisher are to be congratulated on the appearance of so extended and so thorough a work on a subject of such fundamental importance to the entire field of engineering practice.

## Largest Pipe Organ in the World for St. Louis.

One of the most interesting musical and semi-electrical features of the St. Louis Exposition will be the immense pipe organ built by the Los Angeles Art Organ Company, of Los Angeles, Cal., for the Kansas City Convention Hall Company, and which will be the official concert organ at the Festival Musical Hall. It is, we understand, the largest pipe organ in the world, and is certainly the largest aggregation of musical mechanism placed under electrical control. It is 63 ft. long, 30 ft. deep, 50 ft. high. It has 10,059 pipes. The largest metal pipe is 37 ft. 6 in.; weight, 840 pounds; smallest metal pipe, ¼ in., 3/16 in. diameter; weight less than ½ ounce. The largest wood pipe is 22 x 27 in. inside; stock, 2½ in. thick, 32 ft. long; it weighs 1,500 pounds. Over 80,000 ft. of lumber were used in the organ interior; this does not include that used in the construction of the case. It has 130 miles of electric wire, 140 speaking stops, 1,300 magnets, 99 mechanical movements and is capable of producing 17,179,869,183 distinct tonal combinations. It takes 12 large furniture cars to move it and weighs 250,000 pounds.

Fig. 1 herewith shows the organ set up in the factory, without the display pipes; and its relative size can be inferred from the surrounding objects. The instrument will be played from two independent consoles of the most perfect construction and design. The most important console is movable (Fig. 2) and is connected to the organ by an electric cable 150 ft. long. This console contains the

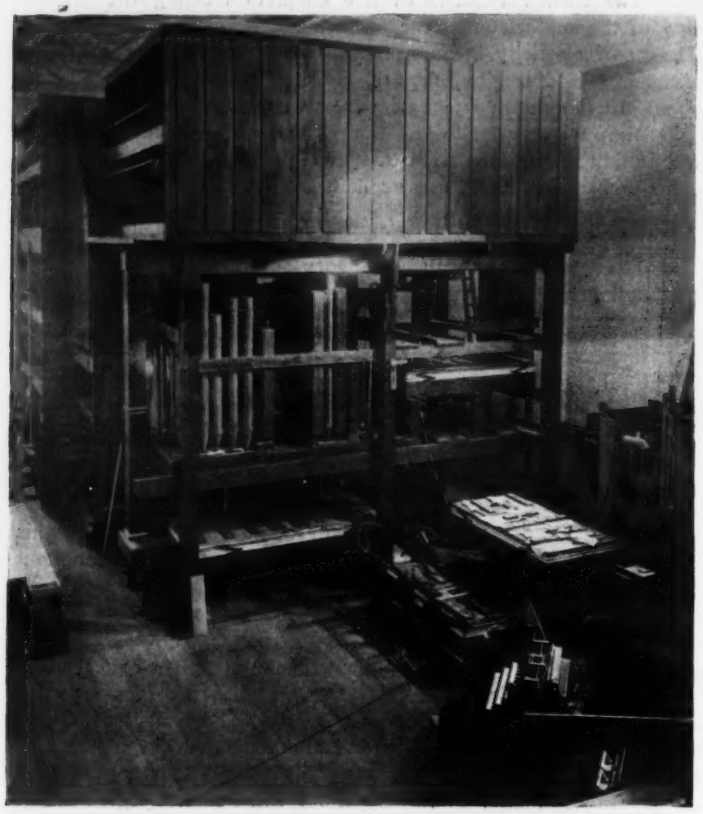


FIG. 1.—ST. LOUIS FAIR PIPE ORGAN.

radiating and concave pedal clavier, the five manual claviers, the 140 draw stop knobs, the five tremulant draws and the 36 coupler draws, the 46 push buttons belonging to the adjustable combination system, and all the foot pedals controlling the expressive powers of the whole organ, etc., etc. This console is for the virtuoso who performs in the usual manner with hands and feet.

The second console is stationary, and is entirely devoted to the builders' double-roll automatic self-playing attachment. Through the agency of the double or twin rolls, the most complicated orchestral scores can be rendered with absolute accuracy, and compositions can be performed which are far beyond the powers of the most accomplished organist. This console resembles that first described, except that it does not possess the manual and pedal claviers, which are not necessary where the double-roll, self-playing attachment appears. Within its arms, so to speak, sits the musician, entirely unembarrassed with the calls of six claviers upon his hands and feet, having at his immediate command the vast tonal forces (represented by 10,000 pipes) of this gigantic organ; his hands simply engaged in manipulating the draw-stop knobs and combination buttons, and his feet controlling the flexible and expressive powers of the instrument. The double rolls do all the rest.

The bellows of the main portion of the organ will be operated by two 10-hp motors, at 220 volts, direct current. The echo organ bellows will be operated by a 1½-hp motor of 220 volts, direct current. The wind-chests, through which the wind from the regulators is distributed to the 140 speaking stops, and the 10,059 pipes, are

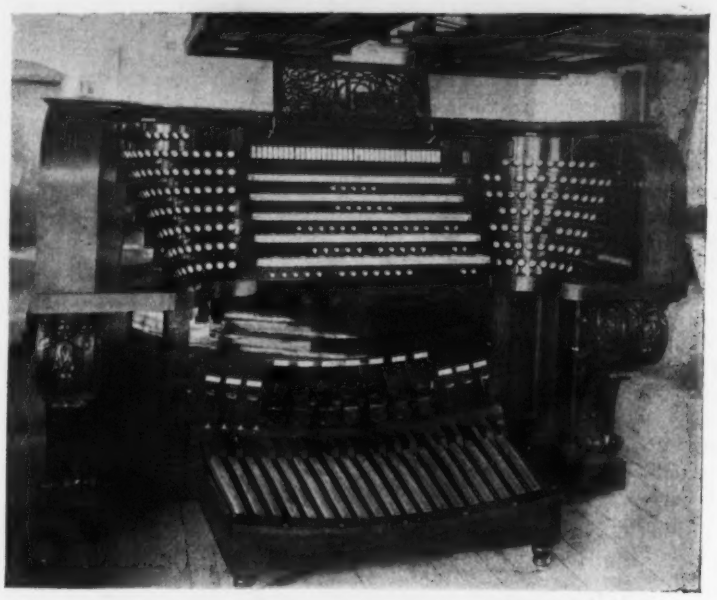


FIG. 2.—CONSOLE OF ST. LOUIS FAIR PIPE ORGAN.

12 ft. long and of widths sufficient to give every rank of pipes planted thereon ample speaking room.

The organ is constructed under the Fleming electropneumatic system, which gives the most satisfactory results. The organ contains 1,300 magnets, as noted above, for both key and draw-stop actions. There are 130 miles of wire in magnets and cables, from No. 20 up to No. 34 B. & S. gauge. There are also 1,616 automatic combination knobs for setting combinations electrically throughout the organ. There are five automatic electric swell engines for the

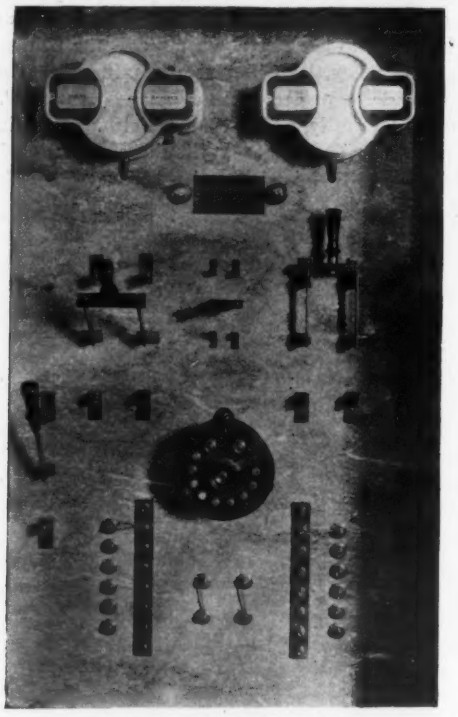


FIG. 3.—SWITCHBOARD.

actuation of the swell shutters. There are above 7,000 open circuits in the organ. The company's special contact wire, of unusual costliness, is used in the key and coupler actions. The single-contact system is used, so arranged as to be durable and always reliable. The coupler action contacts clean themselves automatically, and all trouble is thereby prevented. The storage batteries used will have four cells of two volts each, with normal discharge of 50 amp

for eight hours. There will be a motor-generator of 220 volts, direct current, with a capacity of 10 volts and 40 amp., to charge the batteries.

The switchboard (Fig. 3) has a voltmeter and ammeter to show the discharge voltage and strength of the batteries at all times. There will also be a polarity indicator, also a pilot lamp, which will indicate, to a certain extent, the strength of the batteries. There are also a voltmeter and an ammeter on the switchboard, one showing the voltage charging the batteries and the other showing the amount of the current going into the batteries. Switches are provided for throwing the generator on and off, and for throwing the current off the organ when not in use. The switchboard consists of a marble slab mounted in a handsome oak case with glass door for display purposes.

The entire instrument was built under the personal supervision of Mr. W. B. Fleming, the inventor of the system which bears his name.

## Speed Lathes.

Embodied in the construction of the "Star" speed lathes are several new features of interest to users of this class of tools. The spindle is made from a crucible steel forging, has large hole and runs in large phosphor-bronze bearings, which are self-oiling and dust-proof. Each bearing is oiled by a double set of oiling wicks, which supply the bearing continuously with a liberal amount of oil. The surplus oil runs back into the oil wells, which prevents dripping and waste of oil. After the oil wells have been filled with a good quality of lubricating oil the lathe will then run for a long time

SPEED LATHE.

without further attention in this respect. The cone pulley has four steps, is turned inside as well as outside and is in perfect balance for high speeds. The head stock is the web pattern, strong and heavy.

The tail stock is the curved or cut-under pattern, the tail spindle having a new combination screw and lever motion with graduated dial. The dial is graduated by sixteenths and is valuable for drilling, counterboring, countersinking, etc., to a desired depth. The dial is movable and may be set at any point. To change from screw to lever motion it is only necessary to loosen the thumb screw releasing the spindle sleeve. The long hand lever can be lifted off when not in use. The tail stock has a long bearing on the ways and is firmly locked to the bed by a convenient lever—always attached—no wrench being required. The hand rest is provided with short and long T-rests, the rest socket and saddle are locked to the bed by a cam-locking device and the T-rest is held in its socket. Both are operated by levers always attached.

The bed is broad, deep and, being thoroughly braced by cross webs, is very stiff and rigid. The front way is flat and the back way is V-shaped. A convenient shelf is secured to the back of the bed for the reception of tools, etc. The countershaft has self-oiling and self-aligning shaft bearings, four step cone and tight and loose pulleys.

Each lathe is furnished with a face plate, two point centers, and, when desired, with slide rest, draw-in chuck and collets, etc. The 10-in. and 12-in. "Star" speed lathes are made by the Seneca Falls Manufacturing Company, 422 Water Street, Seneca Falls, N. Y.

## Motor Starter for Variable Speed Work.

There is a large demand for a motor starter with which is combined a field regulating resistance for use with variable-speed motors, the speed range being obtained by field control. The requisites for this combination may be stated as follows:

1. That the field rheostat shall be so interlocked with the motor

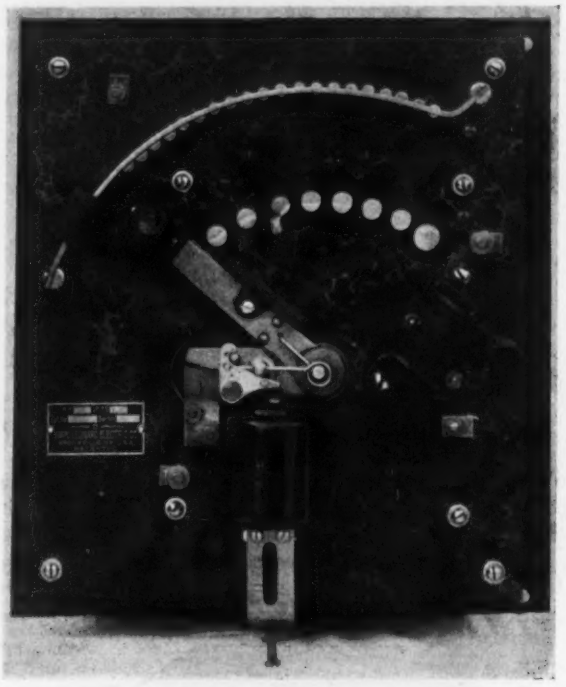


FIG. 1.—MOTOR STARTER.

starter that the motor cannot be started under condition of weak field. 2. That the field rheostat must have twenty or more steps

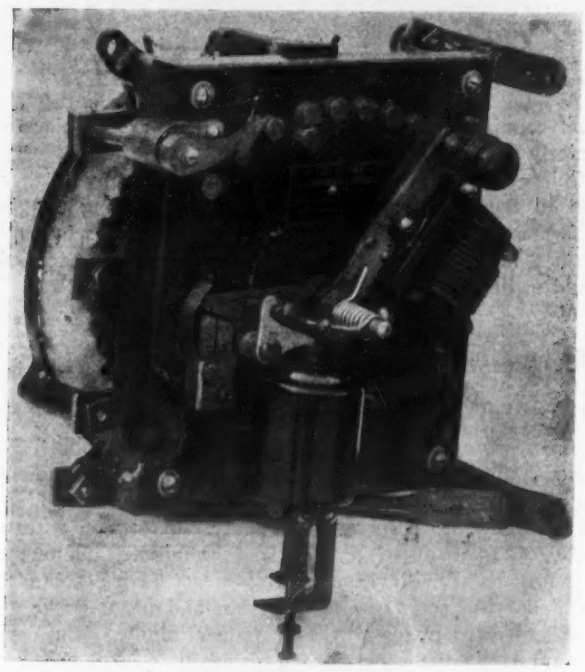


FIG. 2.—MOTOR STARTER.

(at least 20) in order to give even gradations of control. 3. That the starter must be entirely enclosed—to prevent short-circuits due to flying of metallic chips, etc. 4. That the starter must be equipped with an independent interlocking circuit-breaker which will protect

the motor at all times, both during the period of starting and in the full running position. 5. That the no-voltage release must be independent of the field strength and connected across the armature terminals (it is not satisfactory to connect this no-voltage release across the line, as an arc will be formed at the switches when opened if so connected).

The Ward Leonard Electric Company has constructed a combination starter, as shown in the accompanying cuts, which is claimed to entirely fulfil all the above conditions, and also meets the specifications of the United States Government regarding such apparatus.

## Outlet Switch Boxes.

Recent changes in the rules of the Underwriters' National Electrical Association affect outlet boxes. The Chicago Fuse Wire & Manufacturing Company, Chicago, New York and Buffalo, is making the "Union" outlet switch box designed to fit all makes of rectangular push button switches and flush receptacles. The "Union"

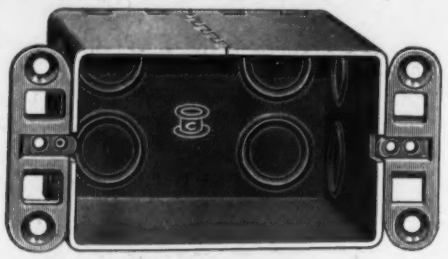


FIG. 1.—OUTLET SWITCH BOX.

box fulfils the latest requirements of the Underwriters in all respects and has "knock-outs" in the bottom and ends of the full thickness of the walls. Special attention is called to the fact that this box is formed from cold-rolled sheet steel of heavy gauge and is dove-tailed together, making it perfectly smooth outside, so that it will slip into a recess in plaster or woodwork, leaving the wall

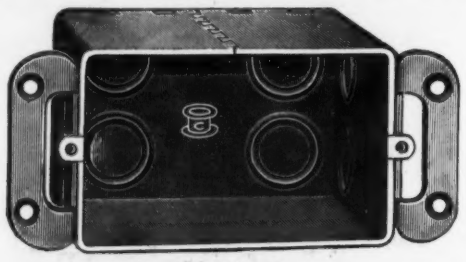


FIG. 2.—OUTLET SWITCH BOX.

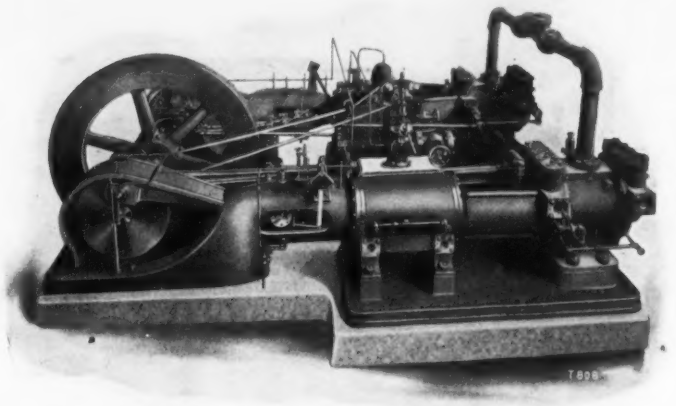
in perfect condition when the switch and plate are in place. The box is nicely finished in black enamel.

The Chicago Fuse Wire & Manufacturing Company further call attention to the adjustable feature in Fig. 1, making this box a perfect fit for any style, while Fig. 2 takes all switches having connections 3¼ in. c. to c. There is also a further style for specific plates and switches.

## Compressed Air Power Plant at the St. Louis Exposition.

The central compressed air power plant at the St. Louis Exposition will contain two main compressing units, one cross-compound, two-stage Cincinnati-gear compressor, having 13 and 24-in. steam cylinders, 22 and 14-in. air cylinders and 24-in. stroke, with a displacement at 125 r.p.m. of 1,300 cu. ft. per minute, and one cross-compound, two-stage, Meyer-gear compressor, having 12 and 20-in. steam cylinders, 18 and 11-in. air cylinders and 18-in. stroke, with a displacement at 100 r.p.m. of 530 cu. ft. per minute. The first machine is to supply the general compressed air requirements of the Exposition, while the second is to supply the transportation exhibits. The larger machine is of special interest as being the first compressor of its type publicly exhibited, although a number of similar machines have been, and are being, installed in private plants. A 2,800-ft. machine is at the present time being placed in the Jersey City power house of the Central Railroad of New Jersey.

The general construction of one of these machines is herewith shown. The frames, as will be noted, are of massive construction, with a long bearing on the foundation, while the steam and air cylinders, joined in the direct line of thrust by heavy cast-iron housings, are also supported by bed plates under their entire length, the weight of each side being thus taken on two large bearing surfaces extending to the ends of the machine, avoiding the objectionable features of overhung cylinders, and giving the compressor great stability. The general construction is characteristic of the best grade of engine work, and comprises removable quarter boxes and main bearings, steel-forged connecting rods, with wedge take-up, specially large crank and wrist pins and cast-steel cross heads with adjustable babbitted slippers, top and bottom, working in bored guides. The reciprocating motion is of the simplest possible character, this simplicity in construction permitting low reciprocating weights without sacrifice of strength. These features allow satisfactory balancing, and, in connection with the long bearing on the foundations, insure an especially easy-running machine. The steam valve gear is of the four-valve type. Steam distribution is effected by means of short, double-ported, slide valves, working at either end of the steam chest on a valve face as close as possible to the cylinder bore, the port volume being restricted as far as the large valve area will allow. The exhaust valves are of the Corliss rotary type and are placed at the bottom of the cylinder. This construction has been followed in order to produce a valve gear having the essential advantages of a Corliss, namely separate passages for



COMPRESSED AIR PLANT.

the steam and the exhaust with corresponding reduction in cylinder condensation, together with short, straight ports and small clearance. On the other hand, the complicated Corliss releasing gear has been eliminated, the action being positive throughout.

The air valve gear is, however, the distinguishing feature of this machine, combining in a very ingenious manner the positive action, noiseless operation and durability of the mechanically-moved valve with the elasticity of the poppet valve. The noise and rapid wear of the poppet valve, due to the impact of the valves closing at the reversal of stroke, is eliminated by mechanically closing the passages underneath the poppet valve, and leaving a cushion of air upon which the latter seats. The three fixed points in the compression cycle, namely the opening of the inlet, the closing of the inlet, and the closing of the discharge, are positively and mechanically controlled; the opening of the discharge, which is the only variable point in the cycle, is controlled by the automatic poppet valves, which are relieved, however, of the necessity for quick closing, and are consequently free from the objectionable features of noise and rapid wear.

The cards from one of these machines, operating at a speed of 150 r.p.m., show a steep expansion line on the air cards, indicative of the small clearance and high volumetric efficiency of the machine, the large valve area being indicated by the practical coincidence of the inlet and atmospheric lines and by the uniform discharge line. The rounded admission of the steam cards, which might in ordinary engines be deemed objectionable, is due to the maker's practice of giving the steam valves a slight negative lead to offset the expansion pressure at the beginning of the air cards. These machines are built by the Laidlaw-Dunn-Gordon Company, of Cincinnati, Ohio.

# NEWS OF THE WEEK.

## Financial Intelligence.

THE WEEK IN WALL STREET.—The tone of the stock market was heavy, and there was a general unsettled feeling, due to unfavorable war news, poor reports about the iron trade prospects and absence of outside support. The death of Mr. W. C. Whitney occasioned some scattered selling of stocks of traction and other interests with which he was formerly identified, Brooklyn Rapid Transit being particularly weak at the close. United States Steel securities were quite heavy for a time on unfavorable reports as to the steel and iron trades and on talk of poorer earnings. Under the influence above mentioned Brooklyn Rapid Transit suffered a net loss of 6¾ points on the week's trading, which was active, 149,870 shares having been sold. The closing quotation was 40⅜, which was only ⅜ above the lowest figure of the week, the highest being 47⅜. Metropolitan Street Railway ranged in price between 117 and 120½, closing at 117½, this being a net loss of 3½. Manhattan Elevated closed at 142¼, a loss of 1¼. The electrics—General Electric, Westinghouse, Western Union and Telephone—were all down, General Electric, however, suffering the smallest loss of all, viz., ⅛ point, closing at 170. Westinghouse common lost 6 points, closing at 161; Western Union, 1, closing at 87¾, and American Telephone and Telegraph, 2 points, the last price of the week being 126. In the curb market nearly everything was reactionary in sympathy with the downward tendency in the stock market rather than because of any special developments. In Electric Boat holders are firm, asking 25, while only 10 is bid. Electric Vehicle is held at 10, with 8 bid. New York Electric Vehicle Transportation is quoted at 5½ bid, with 6 asked. Following are the closing quotations of February 9:

NEW YORK.

| | Feb. 2 | Feb. 9 | | Feb. 2 | Feb. 9 |
|---|---|---|---|---|---|
| American Tel. & Cable | 82 | 82 | General Electric | 170 | 167 |
| American Tel. & Tel | 126 | 124 | Hudson River Tel | .. | .. |
| American Dist. Tel | 22 | 22 | Metropolitan St. Ry | 120¼ | 117¼ |
| Brooklyn Rapid Transit | 45⅝ | 41 | N. E. Elec. Veh. Trns | .. | .. |
| Commercial Cable | 175 | 183 | N. Y. & N. J. Tel | 137½ | .. |
| Electric Boat | 18 | 17 | Marconi Tel | .. | .. |
| Electric Boat pfd | 45 | 40 | Western Union Tel | 88 | 87¼ |
| Electric Lead Reduction | 1 | 1 | Westinghouse com | 165 | 161½ |
| Electric Vehicle | 9 | 9 | Westinghouse pfd | 180 | 175 |
| Electric Vehicle pfd | 13½ | 13 | | | |

BOSTON.

| | Feb. 2 | Feb. 9 | | Feb. 2 | Feb. 9 |
|---|---|---|---|---|---|
| American Tel. & Tel | 127 | 124 | Western Tel. & Tel. pfd | 82 | 81* |
| Cumberland Telephone | 113 | 114½ | Mexican Telephone | 1⅛ | 1⅛ |
| Edison Elec. Illum | 236 | 236 | New England Telephone | 121 | 120½ |
| General Electric | 170 | 167 | Mass. Elec. Ry | 21⅛ | 20⅛ |
| Western Tel. & Tel | 10 | 10* | Mass. Elec. Ry. pfd | 78 | 77 |

PHILADELPHIA.

| | Feb. 2 | Feb. 9 | | Feb. 2 | Feb. 9 |
|---|---|---|---|---|---|
| American Railways | 44 | 44 | Phila. Traction | 97⅝ | 97½ |
| Elec. Storage battery | 59 | 50 | Phila. Electric | 6 | 6 |
| Elec. Storage Battery pfd. | 59 | 50 | Phila. Rapid Trans | 14⅝ | 13⅞ |
| Elec. Co. of America | 8⅛ | 7⅞ | | | |

CHICAGO.

| | Feb. 2 | Feb. 9. | | Feb. 2 | Feb. 9 |
|---|---|---|---|---|---|
| Central Union Tel | .. | .. | National Carbon pfd | 70 | 94 |
| Chicago Edison | 150 | .. | Metropolitan Elev. com | 17 | 17 |
| Chicago City Ry | 165 | 168 | Union Traction | 5 | 5 |
| Chicago Tel. Co | .. | .. | Union Traction pfd | 30 | 29 |
| National Carbon | 28 | 28* | | | |

*Asked

CUYAHOGA TELEPHONE REPORT.—The comparative statement of earnings and expenses for the year ended December 31, 1903, for the Cuyahoga (independent) Telephone Co. of Cleveland, follows:

| | 1903. | 1902. | Changes. | |
|---|---|---|---|---|
| Gross | $396,490 | $385,852 | Inc. | $10,638 |
| Exp. and taxes | 216,460 | 229,709 | Dec. | 13,249 |
| Net | $180,030 | $156,143 | Inc. | $23,887 |
| Charges | 129,259 | 155,600 | Dec. | 26,341 |
| Surplus | $50,771 | $543 | Inc. | $50,228 |
| Employes' share of profits (for six months) | 4,155 | ..... | Inc. | 4,155 |
| Net surplus | $46,616 | $543 | Inc. | $46,073 |

JOHN T. HUNT.—A meeting of creditors of John T. Hunt, who did business as Zimdars & Hunt, electrical contractors, at 127 Fifth Ave., New York, who made an assignment recently, was held at the office of Goeller, Shaffer & Eisler, 207 Broadway, and a committee was appointed to make an examination and report a basis of settlement. The liabilities are about $50,000 and assets estimated at from $28,000 to $30,000. Hunt started in business in 1879 with C. E. Zimdars as a partner. They continued together until 1887, when Mr. Zimdars withdrew and the latter's wife became partner up to February, 1903, when Mr. Hunt bought her interest, and he has since continued the business alone under the old firm style. The causes of the assignment were the long strike in the building trade last summer and fall, and the recent stringency in the money market.

STANDARD UNDERGROUND CABLE CO.—The annual report of this company, as noted on next page, makes an excellent financial showing. The board of directors elected for the ensuing year is as follows: Mark W. Watson, John B. Johnson, James H. Willock, Robert Pitcairn, J. N. Davidson, John Moorhead, B. F. Jones, Jr., Joseph W. Marsh and W. A. Conner. The only change in the board is represented by the election of W. A. Conner, who has been at the head of the manufacturing department of the company since 1884. At the meeting of the board of directors for purpose of organization, held on January 29, the former officers were re-elected as follows: Mark W. Watson, president; Joseph W. Marsh, vice-president and general manager; Frank A. Rinehart, treasurer, and C. M. Hagen, auditor.

ALBANY TRACTION MORTGAGE.—The Board of Directors of the United Traction Company, operating the traction system of Albany and Troy, has approved of a financial plan, the main feature of which is the issue of a mortgage for $6,500,000. The issue is to be used for the redemption of outstanding bonds of the subsidiary companies as they mature and to pay for improvements already made and in progress, while $1,339,000 is reserved for future extensions and betterments. Nine hundred thousand dollars in bonds will be offered for sale at this time. The Central Trust Company of New York is to be trustee under the mortgage. The plan contemplates, it is said, some extensions or consolidations with other roads.

BATAVIA, N. Y., LIGHTING TROUBLES.—Under a decision rendered by Justice Truman C. White and filed in the County Clerk's office at Batavia, N. Y., in the Supreme Court action brought by Mrs. Frances A. Baker, of Rochester against the Consolidated Gas and Electric Company of Batavia and others, the foreclosure is ordered of a second mortgage for $20,000 on the company's property and Edward C. Atwater, of Batavia, an attorney who is secretary of the Batavia Carriage Wheel Company, has been appointed receiver of the Consolidated Company.

DIVIDENDS.—The directors of the Niles-Bement-Pond Co. have declared the regular quarterly dividend of 1½ per cent. on the preferred stock, payable February 15. A semi-annual dividend of 4 per cent. was also declared on the common stock, 2 per cent. payable March 19, and 2 per cent. June 18. The directors of the Pratt-Whitney Co. declared the regular quarterly dividend of 1½ per cent. on the preferred stock, payable February 15.

MARCONI WIRELESS TELEGRAPH business is reported increasing to such an extent that the Marconi Wireless Telegraph Company of America shows the astonishing fact that the business passing through Marconi shore stations in America to and from Atlantic steamers, had gained 350 per cent. in December, 1903, as compared with 1902. At this rate a good showing ought to be made for the year.

## Commercial Intelligence.

THE WEEK IN TRADE.—Trade and transportation are affected throughout the West by the weather conditions, while in the East retail winter trade is reported good. As to spring trade, however, some irregularity is noted. The market in the principal commodities was excited. War news was the ostensible cause of this, although speculation is responsible, too, to some extent. Wheat supplies are 25 per cent. smaller than a year ago; country offerings are light; milling requirements have been heavy and a large short interest in May has been forced to cover at a loss. Taking the situation as a whole, however, there is every reason for confidence as to the spring outlook, the irregularities noted here and there being only superficial and temporary. There is little change in the iron trade. Snow blockades have had the effect of reducing supplies and strengthening prices in the East, but buying is limited. Finished products do not show any special activity. The sales of 40,000 tons of rails to a Canadian railway is reported at a price $5 below the rate asked the American roads. Plates and structural material are quiet; wire is selling well, however. Agricultural hardware is in good demand in the West. Other metals—copper, tin and lead—are all lower. In the copper market, there was greater weakness, and

official quotations have been marked down ¼c. Lake is quoted at 12⅜ a 12⅝c.; electrolytic 12¼ a 12½c.; casting stock 12¼ a 12⅜c. The business failures during the week ending February 4 were about the average in number, *Bradstreeet's* making the aggregate for the United States 216, as against 242 the week previous, and 208 the corresponding week in 1903.

ELECTRIC POWER FOR BRIDGE.—The McCombs Dam bridge across the Harlem River, New York, has one of the largest and handsomest highway draw spans ever built. It is 400 feet long, and has a 40-foot roadway and two sidewalks each nearly 10 feet wide. The moving mass weighs about 2,200 tons, and until now has been operated by a 40 hp oscillating cylinder steam engine with differential gear reducing its speed from 19 to 1. The ends of the bridge were lifted by a separate mechanism with hydraulic jacks driven from an accumulator in the engine room. It was locked by hydraulic centering rams. About two minutes was required to open or close the draw, and the cost of maintenance of the mechanism was very large. In order to simplify and expedite operations, the engine has been replaced by a 20 hp alternating-current motor furnished by the General Electric Company, and believed to be the first one of this size and character applied to such purposes. The motor is also connected by a clutch to a system of gears and shafts, which extend from the centre of the bridge to both ends and operate toggle joints which replace the hydraulic lifting apparatus. The latch has also been replaced by an automatic device designed by Boller & Hodge, New York. Only one man will be required where three were previously needed, and it is believed that the bridge can be swung open or shut in one minute or less. The improvements have been made by the employees of the Department of Bridges, New York, Mr. Martin Gay, assistant engineer in charge of structures on the Harlem River. The machine work was done in the Brooklyn Bridge machine shops.

MEXICAN WATER POWER PROJECTS.—There are a number of new projects to develop water power in Mexico for electric light and power purposes and for irrigation. Theodore V. Peereborm and associates have acquired a concession from the Mexican authorities for the purpose of utilizing 40,000 liters of water per second from the Janapa River located near Cordoba in the state of Vera Cruz. The power will be used for generating current for light and power use in that vicinity. Another scheme is to build a plant on the Rio Grande River, in the State of Chihuahua, permission having been secured by Edward T. Le Clair. The franchise concedes the use of 15,000 liters per second. Fernando Gonzalez proposes to utilize the water of the Amacusac River for the irrigation of the valleys of the Iguala and Cocula, State of Guerrero. Charles Connant plans to use 20,000 liters of water per second from the Yagin River in the district of Guaymas, State of Sonora. His is, also, an irrigation scheme. The Walthalla Colonization Company anticipates the construction of a large irrigation plant which will be used to flood a large area of agricultural land in the vicinity of Naranja, State of Jalisco.

MEXICAN TRACTION PLANS ACCEPTED.—The plans of the Mexican Traction Company for the electrical conversion of the Circuito de Barrios tramways, a mule line operating in the heart of Mexico City, have been approved by the municipal authorities. The company has made application for permission to extend the Barrios line into the Colonia del Paseo, and the Colonia Nueva del Paseo and also into various streets of the American colony. Mr. R. M. McAdoo, of 15 Wall Street, is president of the company. He is now in Mexico. Pittsburg capital will build the system which will aggregate more than 100 miles. The initial capacity of the power plant will be 2000 hp. Twenty 40-feet cars with four motor equipments of 56 hp each will be ordered in the first instance. The Pittsburgers primarily interested in the enterprise are James B. Oliver, Julius Breler, Reuben Miller, James H. Park and Frank B. Smith, all of whom outside of Mr. Oliver are prominently identified with the Crucible Steel Company. A. T. Montmorency, of Mexico City, is the chief engineer of the company. The entire system is expected to be in operation in about twelve months.

STANDARD UNDERGROUND CABLE CONFERENCE.—The annual conference of the branch office managers of the Standard Underground Cable Company with the general sales, the manufacturing, the construction and the executive departments of the company, was recently held in the general offices of the company in the Westinghouse Building, Pittsburg, the session covering three days. The report of each manager for the year 1903 and the business prospects for the year 1904 was presented and discussed, together with ways and means for rendering more efficient service in every department to the customers of the company, who now number considerable over 1,000. A pleasant social feature of the occasion was a theatre party given by Mr. J. W. Marsh, vice-president and general manager of the company, to the visiting managers. The branch office managers attending the meeting were Mr. Charles J. Marsh and Mr. George L. Wiley, from the New York office; Mr. Frank Clark Cosby, from the Boston office; Mr. T. E. Hughes, from the Philadelphia office, and Messrs. J. P. Wiley and E. J. Pietzcker, from the Chicago office.

PACIFIC COAST POWER TRANSMISSION.—The Corona (Cal.) Gas and Electric Company will run a three-mile transmission line to the Auburndale tract to furnish power there and at intervening points. George and Albert Le Gaye, who have bought 300 acres of the former town site in the Auburndale tract, of W. H. Jameson for $7,000, will use a greater part of it for raising alfalfa. They will sink wells and install a pumping plant. The dynamos are now running almost the full capacity. The company intends to duplicate the plant as soon as necessary.

JAPANESE MUNICIPAL TRACTION PROJECT.—The municipal authorities of Osaka—the principal commercial city in Japan—propose to construct an extensive electric traction system. City bonds to the amount of 3,500,000 yen—about $1,250,000—are to be issued for the purpose of capitalizing the undertaking. This is the first instance of the construction and operation of a street railway being mooted by a Japanese municipality, all such enterprises so far having been undertaken by private capitalists. We trust that the war will not interfere with the enterprise.

MEXICAN ELECTRIC RAILWAY PROSPECT.—The Mexican advices state that a local syndicate is being organized in the City of Puebla, State of Puebla, Mexico, with a view to constructing an electric railway between that important Mexican city and Totinshuecan. Francis Barnard, the manager of the Ferrocarril Urbano de Puebla and the Ferrocarril Industrial de Puebla, is primarily interested in the project. The length of the road will be about seven miles.

PARSONS TURBINES FOR SYDNEY.—Parsons steam turbines have been ordered for installation in the extension of the Ultimo central power station of the Sydney city and suburban electric traction system, operated by the New South Wales government. The existing power house equipment was contracted for with the General Electric Company, the engines being of Allis build. The additional installation will have a capacity of about 5000 horse power.

AMERICAN TELEPHONE ORDERS.—Among switchboard shipments recently reported by the American Electric Telephone Company of Chicago, are the following: Hotchkiss, Colo., 100 line express; Neodesha, Kan., 100 line special; Wauseon, Ohio, 100 line express; Urbana, Ohio, 105 line express; Topeka, Kan., two shipments 100 line express; Plainsboro, N. Y., two, 30 capacity special; Milwaukee, Wis., 100 line express.

JAPANESE STREET RAILWAY PROJECT.—A scheme to construct an electric railway between Kyoto and Otsu, as proposed by Mr. Asano, of Tokio, and other Japanese capitalists has, according to advices just received here, been approved by the leading business interests in both cities, and a syndicate is in process of formation for the purpose of carrying out the enterprise. The length of the road will be some 30 miles.

YUCATAN ELECTRIC TRACTION PROJECT.—The United Railways of Yucatan which operates the majority of the steam roads in Yucatan, propose to convert the existing mule roads in the capital city, Merida, into electric traction, and to construct more lines. The New York purchasing agents for the United Railways are Thebaud Bros., 87 Broad Street. It is expected that some 30 miles of track will be electrically operated.

EQUIPMENT FOR NOME PLACER MINING.—The Puritan Gold Mining Company of Nome, Alaska, of which W. H. Powell, of Milwaukee, is president, is about to purchase considerable electrical equipment to be used for operating dredges at the company's property, which is located about two miles from Nome City. The company is incorporated under the laws of Wyoming with a capital of $2,000,000.

GENERAL ELECTRIC MOTORS FOR MEXICAN MINE PUMPS.—The General Electric Company has secured a contract for a number of motors varying in capacity up to 200 hp for direct connection to centrifugal pumps built by the International Steam Pump Company, for installation in Mexican mines.

NEW TELEPHONE SYSTEM FOR MANILA.—The Manila Telephone Company, which operates the present system in the Philippine capital, is to modernize and considerably extend the installation which will necessitate the purchase of a large quantity of equipment on this side.

STEEL STACK FOR MANILA POWER HOUSE.—The Riter-Conley Manufacturing Company, of Pittsburg, Pa., has secured the contract for the large steel stack for the power house to be built by the Manila Electric Lighting and Railroad Corporation.

BALL ENGINE ORDER.—The Continental Coal Company, Columbus, Ohio, has recently placed in operation two 400 hp heavy duty side crank engines, built by the Ball Engine Company, Erie, Pa., at its mine, No. 255, Jacksonville, Ohio.

# General News.

## THE TELEPHONE.

TOMBSTONE, ARIZ.—The Tombstone Telephone Company has been incorporated by E. T. Ijams, E. U. Ijams, W. C. McFarland and others. The capital is $180,000.

CONWAY, ARK.—The Conway Telephone Company has been incorporated with a capital stock of $10,000. L. H. Pyle is president.

DARDANELLE, ARK.—The Arkansas Telephone Company has been incorporated with a capital stock of $20,000. The incorporators are: J. B. Crownover, W. R. Hayden, A. L. Blackwell, C. W. Brown, A. D. Perry and Geo. N. Goodier.

ANAHEIM, CAL.—The City Council has adopted a resolution to advertise for sale the telephone franchise requested by the Home Telephone Company.

SAN FRANCISCO, CAL.—The Sunset Telephone & Telegraph Company has been incorporated with a capital stock of $3,000,000, the amount actually subscribed being $10,000. The object of the company is to deal in all kinds of electrical supplies in the Pacific Coast states. The company is to build lines throughout this section of the country, the total length of which is given as 1000 miles. The directors are George S. Ladd, John I. Sabin, Louis Glass and others, of San Francisco.

ATHENS, GA.—It is stated that a new independent telephone system will be established here. Mr. L. D. Goodrum, of Pennsylvania, is promoting the enterprise.

MIDDLETOWN, ILL.—The Middletown Mutual Telephone Company has been incorporated with a capital stock of $2500. The directors are: Thomas Dorgan, P. J. England and others.

TAMPICO, ILL.—The Tampico Farmers' Mutual Telephone Company has been incorporated with a capital stock of $4900. The directors are: W. M. Maloney, A. C. Hunter and others.

DANVILLE, ILL.—The Vermillion County Telephone Company, it is stated, has bought out the Central Union system. This is thought to be the first instance on record where a local company has compelled the surrender of the Central Union. The capital stock of the new company was recently increased from $150,000 to $4,000,000.

CHICAGO, ILL.—The stockholders of the Automatic Electric Company have voted to increase the capital stock of the company to $2,000,000, making the total $5,000,000. This is the company that is manufacturing the equipment for the Illinois Tunnel Company's telephone system in Chicago. It is also at work on orders for thirty other exchanges throughout the country.

CHERRYVALE, IND.—The Cherryvale Telephone Company has been incorporated with a capital stock of $350.

PORTLAND, IND.—There is every indication of a telephone war being inaugurated in this city. The Bell Telephone Company is preparing to establish an exchange in opposition to the Home Telephone Company.

INDIANAPOLIS, IND.—A number of telephone companies in this State have abolished the custom of making a "morning test." Many patrons objected to the unnecessary annoyance and since the practice has been discontinued the service is equally as good.

NEWCASTLE, IND.—It is stated that the independent companies in Henry County will probably be consolidated in the near future. There are nearly 4,000 independent telephones in the county, and the object of the consolidation will be the exchange of service for mutual interest.

SWEETZER, IND.—At the annual meeting of the Sweetzer Telephone Company new directors were elected as follows: L. M. Hoggatt, J. B. Reed, A. Bechtel, J. C. Lake and Louis Oyler. The new board in turn elected Mr. Hoggatt president, Mr. Reed treasurer, and Mr. Bechtel secretary. The report for the year was very gratifying.

LAGRANGE, IND.—The Northern Indiana and Southern Michigan Telephone Company has completed arrangements for better service. The office at Lima will be made an all night office. The company began February 1st to give the market and weather reports over its 14 party lines from Lima to all its subscribers. These reports and the night service has increased the demand for telephones.

SPIRIT LAKE, IA.—The Midland Telephone Company will install a local exchange in this place.

CLARE, IA.—The Fort Dodge Telephone Company contemplates the installation of an exchange in this place.

CEDAR FALLS, IA.—The City Council has granted a franchise for a mutual telephone company in this place, as proposed by Mr. R. A. Davison.

SIOUX CITY, IA.—The Independent Telephone Company has the contract for the construction of a toll line from Odebolt to this city, a distance of 60 miles, and another to Lemars, 25 miles.

FORT DODGE, IA.—The Fort Dodge Telephone Company has elected officers for the coming year as follows: O. M. Oleson, president; C. D. Koch, vice-president; L. A. Thorson, secretary; E. G. Larson, treasurer.

WEBSTER CITY, IA.—Ten different telephone companies operating in Hamilton County have been consolidated. They are the Kamrar Co., the Jewell-Wall Lake Co., the Ellsworth Mutual Co., the Williams Co., the Stanhope & Northeastern Co., the Randall Co., the Jewell & South Cairo Co., the Jewell & Northwestern Co., the Stratford Independent Co., and the Blairsburg Co.

FALL RIVER, KAS.—The Fall River Telephone Company has been incorporated with a capital stock of $3000.

AUGUSTA, ME.—The Amazon Wireless Telegraph & Telephone Company has been organized here with a capital stock of $1,000,000, of which nothing has been paid in. The officers are J. Berry, Augusta, president, and L. A. Burleigh, Augusta, Treasurer.

READING, MICH.—The Central Telephone Company has been incorporated with a capital stock of $10,000.

MARQUETTE, MICH.—Crawford & Sons, timber operators of Cedar River, may build a telephone line from Cedar River to Stephenson in the spring.

DETROIT, MICH.—The stockholders of the Co-operative Telephone Company have approved a bond issue of $50,000 for extensions and improvements.

MURDOCK, MINN.—A telephone line is projected from Murdock to Louriston and Buffalo Lake.

HOWARD LAKE, MINN.—The Howard Lake Telephone Company will make a 10-mile extension in the spring.

MINNEAPOLIS, MINN.—The Twin City Telephone Company has declared the eighth quarterly dividend on preferred stock at the rate of 7 per cent. per annum.

ELKO, NEV.—The Northern Telephone & Telegraph Company has been incorporated with a capital stock of $10,000 by J. G. Taylor, R. H. Mallett and others. The company is already operating a line between Tuscarora, Edgemont, White Rock and Columbia, and will extend it to other points north.

MIDDLETOWN, N. Y.—Te directors of the Orange County Telephone Company have re-elected the following officers: President, Charles Higham; vice-president, A. B. Wilbur, and secretary, W. C. Ramsdell.

WILMINGTON, N. C.—It is announced that the lines of the Long Distance Southern Bell Company will be extended from Wilmington to Florence, S. C., a distance of 110 miles. The Bell Company is taking down the wires of the recently absorbed Interstate Company at Wilmington.

MIFFIN, OHIO.—The Miffin and Widowville Telephone Company has increased its capital from $1000 to $5000.

CLEVELAND, OHIO.—The Telephone Hygenic Company has been incorporated with a capital stock of $100,000. The directors are F. B. Williams, T. H. Hogsett and others.

IRONTON, OHIO.—Eastern capitalists have purchased the property of the Lawrence Telephone Company, having exchanges here, at Ashland, Catlettsburg, Russell and Rush, Ky., and minor points. It is stated semi-officially that the Central Union Telephone Company is the purchaser.

HARRISBURG, PA.—The annual report of the Pennsylvania Telephone Company shows that 368 miles of toll pole lines were rebuilt, and 758 miles of copper metallic circuits substituted for iron wire.

CHESTER, PA.—The Keystone State Telephone & Telegraph Company has begun a general system of renovation along its lines in the county. Two new trunk lines are being constructed to Chester from Philadelphia. In connection with this, the exchange will be removed from Moore and located either in Lansdowne or Darby.

WASHINGTON, PA.—J. T. Bebout, of Claysville, has purchased all of the property of the Federal Telephone Company in Buffalo, Blaine and Donegal townships. Mr. Bebout also purchased interests in the Claysville Telephone Company, which system will be operated in connection with that portion of the Federal system acquired by him. Exchanges will be established at Claysville, Taylorstown and various other points in the townships named.

COLMAN, S. D.—The Colman Electric Telephone Company has been incorporated with a capital stock of $10,000.

MEMPHIS, TENN.—The Memphis Long Distance Telephone Company has executed a mortgage for $1,000,000 with the Tennessee Trust Company as trustee; bonds to this amount to be floated to meet expenses, complete the plant and acquire other properties.

ELKHART, TEX.—The Elkhart Telephone Company which was recently organized here has constructed and put into operation a telephone line to the towns of Slocum and Denison Springs, a distance of fifteen miles. The line will be extended.

MERHERRIN, VA.—The Lunenburg Telephone Company has increased its capital from $500 to $5000.

JANE-LEW, W. VA.—The Beeghley Telephone Company of this place has been incorporated with a capital stock of $50,000. The incorporators are: Lloyd Beeghley, Hattie Beeghley, R. A. Beeghley, Weston, W. Va., Mary A. Swisher, Charles Beeghley, Jane-Lew, W. Va.

DAVENPORT, WASH.—The Creston & Sherman Telephone Company has been granted a telephone franchise on the public highways of the county.

WHEELING, W. VA.—The National Telephone Company has completed connections with the South Penn Telephone & Telegraph Company operating between Waynesburg and Uniontown. The company has also completed a direct line to Mannington, where connection is made with the system of the Consolidated Telephone Company, and the line to Wellsburg is nearly completed.

JANESVILLE, WIS.—The Rock County Telephone Company has decided to extend its lines.

LEEDS, WIS.—The Leeds Farmers' Telephone Company has increased its capital from $5000 to $10,000.

RIVER FALLS, WIS.—The St. Croix Valley Telephone Company has increased its capital stock to $1500.

MADISON, WIS.—The Rhinelander Mutual Telephone Company has increased its capital stock to $10,000.

GRAFTON, WIS.—The Grafton Telephone Company has been incorporated with a capital stock of $4000. The directors are J. G. Buck, F. C. Mintzlaff and others.

RIDGELAND, WIS.—The Dunn County Telephone Company of this place has been incorporated with a capital stock of $10,000 by M. L. Randall, A. L. Pongratz and J. R. Ferguson.

## ELECTRIC LIGHT AND POWER.

DOUGLAS, ARIZ.—A company has been formed here for the purpose of establishing another electric light and power plant. It has a capital stock of $60,000. H. C. Mayer is manager of the new company. The stockholders are F. S. Douglas, W. G. McDonald, A. S. Pierce, C. J. Lachance, D. A. Richardson and others.

SAN FRANCISCO, CAL.—The United Gas and Electric Company held its annual meeting on January 21. The officers elected were: J. E. Green, president; C. E. Green, vice-president, and C. H. Pennoyer, secretary. R. J. Davis replaced George A. Nichols as one of the remaining directors.

MACOMB, ILL.—The Brookfield Gas, Electric & Heating Company of this place has increased its capital stock from $25,000 to $50,000.

AURORA, ILL.—The Aurora, Elgin and Chicago Light, Heat and Power Company has been incorporated, with a capital of $5000. Incorporators: Edwin C. Faber, John T. Huntington and William F. Harvey.

FT. WAYNE, IND.—The City Council has granted a 31-year franchise to the Ft. Wayne Electric Light and Power Company at $70 a year for street lights and 10 cents per kw. for private current. There has been a six months fight over this franchise owing to a sentiment favoring a municipal ownership plant.

JACKSON, KY.—An accident to the engine in the electric light station recently destroyed that machine to such an extent that the city was left in total darkness.

LEWISTON, ME.—Work is soon to be commenced on the new dam across the Androscoggin River. All of the electric power apparatus is on the ground, and it is expected that about 10,000 horse power will be available for distribution in Lewiston and Auburn early in the fall of this year.

ITHACA, MICH.—The managers of the Ithaca Light & Power Company shut down the plant recently on account of the high price of coal, which they claim prevents them from running the plant at a profit, and rather than lose money they decided to close down indefinitely.

GLASGOW, MONT.—Preliminary surveys are in progress for the construction of water works and an electric light plant. A. W. Mahon is the engineer.

LIVINGSTON, MONT.—The new electric light plant of the Livingston Water Power Company, which takes the place of the one destroyed by fire on November 29 last, is now in operation. As yet no street lamps are in service and there will be none until the city pays up its back bills for street lighting. The streets are, therefore, unlighted.

SANTA FE, N. M.—The Capital City Light and Power Company has taken the preliminary steps looking to extending its transmission lines to the city of Albuquerque and Las Vegas. It is proposed to furnish those places with light and power for municipal and commercial purposes. The plans of the company contemplate the construction of a large electric power plant at the Pecos River Falls, situated fourteen miles from Santa Fe. Among those interested in the company are Colonel W. S. Hopewell, manager of the New Mexico Fuel and Iron Company, Santa Fe; J. C. Bonner, of Toledo, Ohio; J. W. Miller, mining engineer, of Denver, Colo., and A. R. Gibson, of Santa Fe.

GREENE, N. Y.—The citizens have voted to issue $4500 bonds, to complete the electric light plant.

HILTON, N. Y.—A. M. Lawrence, of Clyde, submitted an offer to this village to establish an electric light plant.

CATSKILL, N. Y.—The Catskill Illuminating & Power Company has increased its capital stock from $65,000 to $100,000.

BROOKLYN, N. Y.—Bids will be received February 15 by C. B. J. Snyder, Superintendent of School Buildings, New York City, for installing electric equipment in the manual training high school.

CLINTON, N. Y.—The capital stock of the Clinton Electrical Company has been increased by $15,000, and steam will be installed at the power house as soon as weather will permit. Work will be commenced with a view to increasing the water power.

LEROY, N. Y.—The Leroy Hydraulic Electric Company has petitioned the courts for permission to change its name to Leroy Hydraulic Electric Gas Company. The first named company about a year ago purchased the old gas plant and the street lighting plant, and it is now proposed to consolidate the two concerns under the latter title above given.

WINSTON, N. C.—The city of Winston has contracted with the Fries Power and Manufacturing Company for seventy arc lights at $60 per light per year, the contract covering three years, beginning March 31, 1904.

NEWTON, N. C.—Shields, Sons & Co., of Providence, R. I., have secured an option on a valuable water power on the Catawba River near here, and it is said will begin a big electric development to supply power to neighboring cotton mills.

TOLEDO, OHIO.—At the annual meeting of the Toledo Railways & Light Company the present officers and directors were re-elected for the ensuing year. The annual report of President Everett showed that the gross receipts were $1,663,794, an increase of $204,702 over the previous year. The operating expenses were $856,526 as compared with $726,779 in 1902; and the net earnings were $807,279 against $123,312 in 1902.

HARRISBURG, PA.—At the annual meeting of the Harrisburg Light, Heat & Power Company the following named officers were elected:: President, E. Z. Wallower; vice-president, Harry C. Ross; secretary and treasurer, Harry W. Stone; general manager, Charles C. Kinter.

READING, PA.—The following named officers have been elected by the Reading Electric Light & Power Company: Jerome L. Boyer, president, and J. H. Righter, secretary. The company will be twenty-one years old on March 8, and during its existence it has declared 62 dividends amounting to $565,000. This is equal to 200 per cent. on the original capital stock.

PHILADELPHIA, PA.—Judge McPherson, in the United States Circuit Court has issued a decree of foreclosure ordering the sale of the Lehigh Power Company's plant in and around Easton, Pa., to satisfy the claim of the Central Realty, Bond & Trust Company, trustee of the mortgages securing the bondholders. This action was taken on account of the default of the company in the payment of interest due on its bonds amounting to $325,491.25. Mr. Russell C. Stewart was appointed special master to conduct the sale.

WEBSTER, S. D.—The council committee is considering the matter of increasing the capacity of the electric light plant here.

MITCHELL, S. D.—J. B. Mickellsell and Fred. Fairchild have purchased the local electric light plant, and will install additional machinery.

MEMPHIS, TENN.—The Memphis Electric Supply Company has increased its capital stock from $5000 to $50,000.

WACO, TEX.—The citizens have voted to issue bonds for an electric light plant, water works and a sewerage system. F. H. Meader is recorder.

WILLS' POINT, TEX.—The Wills' Point Electric Light Company has been organized with a capital stock of $10,000. The incorporators are O. L. Johnson, Charles E. Brown and W. B. Rogers, all of Wills Point.

MARBLE FALLS, TEX.—It is reported that the falls of the Colorado River at this place are to be utilized for generating electric power for an electric plant that may be installed here. The names of the parties interested are not given.

CISCO, TEX.—The Cisco Electric Light Company has been organized here with a capital stock of $10,000 for the purpose of installing and operating an electric light and power plant. The incorporators are W. A. McSpadden, Aaron L. Mayhew and Abner L. Mayhew, all of this place.

FILLMORE, UTAH.—The city officials are considering the installation of an electric light plant here early in the spring.

ORANGEVILLE, UTAH.—The towns of Orangeville and Castledale are considering the construction of an electric light plant and a joint committee consisting of A. G. Van Buren and J. B. Crawford, of Orangeville, and W. J. Seeley, of Castledale, have been appointed to investigate the matter.

WATERVILLE, WASH.—The City Council has entered into a 15-year contract with George H. Gray & Son, of Entiat, to furnish electric light and power to Waterville at $50 per horse power per annum. The plant is to be in operation by September 1.

OCONOMOWOC, WIS.—The Council has decided to secure bids for improving the electric light plant.

SHELL LAKE, WIS.—The citizens have voted to borrow from the State $10,000 for an electric light plant and water works.

BELOIT, WIS.—The Beloit Electric Lighting Company will expend about $10,000 in improvements. J. S. Allen is manager.

WEST ALLIS, WIS.—The Village Board has granted to the Milwaukee Light, Heat and Traction Company a perpetual franchise for lighting. The company was given a 3 year contract for electric lighting.

PORT ARTHUR, ONT.—At a recent meeting of the council for the town of Port Arthur, the question of further developing the power on Current River received favorable consideration. It is the intention of the council to utilize from 8000 to 10,000 horse power, and to offer the surplus power at a low rate for manufacturers. It is said that taking the cost of the power development on a 5 per cent. interest basis the interest on borrowed cash for this purpose, which the town now pays, brings the cost down to about $4 per horse power per annum.

SHERBROOKE, QUE.—The shareholders of the Sherbrooke Electric Company have decided to accept the offer of the city to purchase the company's electric light plant and property for the sum of $200,000, provided the city will also take over the gas property of the company.

MONTREAL, QUE.—At the annual meeting of the shareholders of the Shawinigan Water and Power Company, the treasurer reported that the company was now selling in Montreal 6000 horse power, and at Shawinigan Falls, 20,000; that there was still a large surplus of power in the development at the Falls, the total being estimated at 100,000 horse power. The operation of the power plant at Shawinigan Falls had proved satisfactory, and the successful transmission of power to Montreal had demonstrated the commercial feasibility of transmission to any point within a radius of 100 miles of the Falls. The company was in receipt of applications for large amounts of power, and extensive additions to its electrical plant will be made.

MONTREAL, QUE.—The Montreal Light, Heat and Power Trust now includes the Montreal Gas Company, the Royal Electric Company, the Montreal and St. Lawrence Light and Power Company, the Imperial Electric Light Company, the Lachine Rapids Hydraulic and Land Company, the Standard Light and Power Company, the Citizens' Light and Power Company, and the Temple Electric Company. Further combinations are looked for, notably that of the Montreal Street Railway Company with which the combine is already closely allied. This trust was formed for the ostensible purpose of cheapening production by combination, but the experience of consumers shows that the cheapening of light and power to them has not resulted. The combination now controls all the lighting and supply of power of Montreal, St. Henri, Ste. Cunegonde, St. Louis, Westmount, Maisonneuve and Cote St. Paul, with a population of 322,327. It also controls the public lighting of the city of Montreal under a contract running until January, 1909. At a recent meeting of the Montreal Board of Trade, it was unanimously decided that electric light and power were too dear, and that steps should be taken to put an end to such monopolies as that of the Montreal Light, Heat and Power Company. It was stated that this company was at present charging its customers four times as much for power as the combination paid for its supply received from the Shawinigan Falls Company.

## THE ELECTRIC RAILWAY.

WATSONVILLE, CAL.—W. J. Rogers has applied for a franchise to construct and operate an electric railway over certain streets in Watsonville. Bids for the franchise will be received up to 8 p. m., February 17. S. W. Coffman is City Clerk.

EAST ST. LOUIS, ILL.—The new power house of the East St. Louis & Suburban Railway Company is expected to be completed some time in March. The company then will abandon its three small outside stations, and depend entirely upon the new plant for power with which to run its cars. During the year the company has introduced a great many improvements. A unique feature has been the installation of a complete telephone system on its suburban lines. All the trolley poles have been numbered, and on every fifteenth pole a telephone connection has been hung. Each car also is equipped with a portable telephone, which can be quickly attached to the pole connection and communication entered into with the sheds, power stations, general office or superintendent's residence. In its annual statement the gross earnings of the company for the year are given as $448,067, and for its electric light plant $526,313, an increase of 36.43 per cent.

COLUMBUS, IND.—The City Council has granted a 50-year franchise to the Indiana Central Electric Railway Company, proposing to build a line from Columbus to Seymour and French Lick.

INDIANAPOLIS, IND.—The Wabash & Rochester Electric Railway, of Wabash, Ind., E. Spencer Pratt, secretary, has filed a mortgage for $900,000. The contract for the construction of the road has been awarded to United States Engineering & Construction Company, of Cleveland, Ohio.

HUTCHINSON, KAN.—The City Council has granted a twenty-year franchise to J. J. Burns, of Chicago, to construct and operate an electric railway in Hutchinson. Mr. Burns plans to purchase the Hutchinson Street Railroad, now being operated with horses.

BOSTON, MASS.—Representative John A. Coulthurst, of Boston, has introduced a bill into the Legislature which calls for the appointment of a special commission of five experts by the Governor to inquire into all public service corporations with a view of obtaining a franchise compensation and other results. The bill takes in all corporations like street railways, steam railroads, telephone and telegraph and gas and electric light companies.

DEERFIELD, MICH.—An effort is being made to obtain right-of-way from Briton through Deerfield for an electric railway, to connect with the Toledo line at Petersburg; a double track is to be laid and everything completed by summer.

BENTON HARBOR, MICH.—J. G. McMichael, of Chicago, has been given a franchise for an electric railway from Benton Harbor to Dowagiac, through Pipestone township. The road will touch all summer resorts along St. Joseph River. The only question now left unsettled is whether the road shall run from Eau Claire to Niles or from there directly to Dowagiac.

MINNEAPOLIS, MINN.—The County Commissioners have sold the old motor line right of way from Hopkins to Excelsior to the Minnesota Power and Trolley Company for $4,000.

ST. PAUL, MINN.—The City Council of South St. Paul has decided to make several amendments to a draft of a street railway franchise, which has been submitted to the council by the Twin City Rapid Transit Company.

GREENWOOD, MISS.—The Board of Trade has called a meeting of citizens to consider plans for building an electric railway from Greenwood to Belzona. This will serve a prosperous country not now reached by any kind of railways. It is proposed to handle both freight and passengers.

ELMIRA, N. Y.—Announcement is made that arrangements have been concluded for the building of a third rail electric railway between Elmira and Corning. The necessary application will be made to the State Railroad Commissioners at once. A private right of way has been secured.

NEW YORK, N. Y.—The Metropolitan Street Railway Company is considering a proposition made to it by Comptroller Grout that it operate cars on the Williamsburg Bridge, as a temporary measure of relief until such time as it will be possible to make arrangements for connecting the bridges on the Manhattan side. The suggestion is that the Metropolitan Company operate its cars on a loop around the Brooklyn terminal of the Williamsburg Bridge, thus obviating the necessity of a franchise in Brooklyn. There is plenty of room for such a loop in the Brooklyn terminal of the structure.

DEGRAFF, OHIO.—The Dayton & Kenton Electric Railway has let a contract to the Farnham Company, of Chicago, for the equipment of its projected line with the Farnham protected third rail. The officers of the electric railway company are: E. M. Hopkins, of New York, president; C. H. Pomeroy, of Saginaw, Mich., treasurer; W. E. Harris, of DeGraff, Ohio, secretary. The plan is to build lines from Dayton to DeGraff, New Carlisle to Springfield, DeGraff to Canton, and DeGraff to Bellefontaine.

NORFOLK, VA.—A company has been chartered here to build an electric railway to Elizabeth City, N. C. The distance is 40 miles. It is said that the Norfolk City Railway, which is owned by the Williams syndicate, of Richmond, is to build the road. General Manager Hathaway denies, however, that the company has any more interest in the charter than a traffic arrangement with the road when built.

BALLARD, WASH.—Surveys are being made in the interest of the Everett-Seattle Interurban Railway. It is understood that a franchise will be presented to the City Council at an early date, asking a right-of-way through the city.

MADISON, WIS.—The Outagamie Traction Company, of Appleton, Outagamie County, has been formed to build and operate an electric railway and power company, capital stock, $30,000; incorporators, Thomas Pearson, W. H. Holcomb, J. A. Hawes, John L. Jacquot and Paul V. Cary.

## NEW INDUSTRIAL COMPANIES.

THE NATIONAL SWITCHBOARD COMPANY, of Jersey City, N. J., has been incorporated with a capital stock of $10,000 by Joseph F. McGrath, Gustavus A. Conover and George E. Groswold.

THE PITTSBURG AUTO-ELECTRIC COMPANY has been incorporated with a capital stock of $6000 by L. A. Ailes, Fred S. Ailes, R. S. Donaldson, E. W. McCormick and James F. Shepperson.

THE CRESCENT ELECTRIC COMPANY of Utica, N. Y., has elected officers as follows: President, J. C. Eichmeyer; vice-president, John Wenzel; secretary, W. P. Campbell; treasurer, A. J. Potter.

THE BOREAS ELECTRIC COMPANY has been incorporated at Washington, D. C., with a capital stock of $1,000,000. The incorporators are: Joseph Stretch, J. H. Lougborough, Jr., and J. Menick Freare.

THE CARBON MOTOR VEHICLE COMPANY has been incorporated in New York with a capital stock of $100,000. The directors are: C. A. Carbon, Brooklyn, and Leopold Soudheim and Eugene Soudheim, New York.

THE RICHARDS-RANDALL TELEGRAPH & TELEPHONE SUPPLY COMPANY of New York has been incorporated with a capital stock of $100,000. The directors are E. M. Jerome, F. M. Randall and G. C. R. Marshall.

THE ZINCOIL POLE COMPANY, of Texarkana, Ark., has been incorporated with a capital stock of $25,000 to conduct a general electrical supply business. The incorporators are John B. King, E. J. Spencer, D. C. Lingo and Charles M. Conway.

THE McKELVEY ELECTRIC COMPANY, of Youngstown, Ohio, has been incorporated with a capital stock of $10,000 to manufacture electrical appliances. The incorporators are: John Reed, Edward McKelvey, E. J. Anderson, F. W. Robinson, A. M. Wendlish and V. J. Laur.

THE CONDIT ELECTRICAL MANUFACTURING COMPANY has been organized at Augusta, Me., for the purpose of manufacturing electrical supplies. The capital stock is $200,000, of which nothing is paid in. The officers are I. L. Fairbanks, Augusta, president, and J. Berry, Augusta, treasurer.

THE BRADLEY RAILWAY SIGNAL & SUPPLY COMPANY, of Providence, R. I., has been incorporated with a capital stock of $100,000 for the purpose of manufacturing and dealing in electric railway block signal systems and electrical supplies in general. The incorporators are Harold E. Bradley, Warwick; Eugene F. Bowen, Providence, and Stephen A. Wood, Providence.

## LEGAL.

WESTERN UNION-BELL ACCOUNTING.—At Boston, on February 3, Judge Colt in the United States Circuit Court ordered the American Bell Telephone Company to give an accounting to the Western Union Telegraph Company, the successful plaintiff in the recent royalty suit against the telephone company. Everett W. Burdett was appointed special master to take charge of the accounting and to hear all evidence that may be presented. The suit of the Western Union Company was to recover royalties from the American Bell Company under the well-known agreement, and the present action is concerning the amount of money to be paid over.

ELECTRIC LIGHT NOT A MANUFACTURE.—A case was settled recently in the Supreme Court of New Hampshire over a dispute arising in the village of Warren. Pub. St. 1901, c. 55, Sec. 11, provides that towns may, by vote, exempt from taxation for a term not exceeding 10 years any manufacturing establishment proposed to be erected or put in operation therein. It was held by the court on appeal that furnishing electric light and power, and distributing the same, was not manufacturing, within such statute, and such business not being separable from a vote exempting an establishment for manufacturing lumber, and furnishing steam and electric power, and distributing the same, from taxation, the entire exemption was void.

"CAR AHEAD" PRACTICE INVALID.—The Appellate Term of the New York Supreme Court—Justices Freedman, Gildersleeve and Greenbaum—rendered a decision last week upholding the ordinance which prohibits street surface railroad companies from compelling passengers to take a "car ahead," and imposes a penalty of $100 for each violation. Justice Gildersleeve wrote the opinion and both his colleagues concurred. It is held that the ordinance which in substance requires street surface railroad companies to carry a passenger "to any regular stopping place desired by him upon such car's route," without change of cars except for transfer to a connecting line going in another direction, or in case an accident renders compliance impossible, is valid and reasonable. Justice Greenbaum, in a concurring opinion which he wrote, went further and said that were it not for the ordinance passengers on street cars would be subjected to peril, traffic would be congested, and much inconvenience caused.

## OBITUARY.

MR. J. L. KEBLER.—We regret to note that Mr. John Leonard Kebler, vice-president and general manager of the Ward Leonard Electric Company, died very suddenly, February 2, at Albuquerque, New Mexico, from an acute intestinal disorder. Mr. Kebler graduated in 1900 from Columbia University, taking the degree of electrical engineer. He was a member of the American Institute of Electrical Engineers and was widely known throughout the entire electrical fraternity. His untimely death comes as a great blow to his associates and to his uncle, Mr. H. Ward Leonard, with whom he has been living for the past 16 years. Mr. Leonard Kebler, his brother, has gone for the remains and will take them to Cincinnati for burial.

## PERSONAL.

MR. W. C. BURTON, of J. G. White & Company, Limited, of London, arrived in New York last week on a business trip round the world.

MR. H. H. STANLEY, of the Columbia Phonograph Company, has sailed for China. He will make his permanent headquarters at Shanghai.

MR. W. B. CHURCHER, and not Mr. W. Scheidel, was the author of the interesting paper on "Rectifiers," presented at the recent annual convention in Milwaukee of the Northwestern Electrical Association.

MR. A. M. HUNT, of the Engineering Offices, San Francisco, is visiting the principal eastern cities. He will return to the Coast via Vancouver, B. C., where his firm is superintending a large electric power installation.

MR. F. E. DRAKE, the well-known electrical manager, now president of the Lanyon Zinc Company, of St. Louis, has been visiting New York city the past week on business matters connected with that important smelting enterprise.

MR. H. F. STEPHENS has been elected general manager of the Central New York Telegraph & Telephone Company in place of Mr. Jeffries Wyman, resigned. Mr. Wyman retains the position as second vice-president of the company.

MR. RICHARD T. LAFFIN, formerly general manager of the Worcester, Mass., Consolidated Street Railway, who was recently appointed general manager of the Manila Electric Light & Railroad Corporation, has sailed for that part of the world.

MR. WM. MAVER, JR., announces that his new book, "Maver's Wireless Telegraphy, Theory and Practice," will be issued February 15, 1904. It will be a valuable treatise on the art, especially on the practical side, many details of which have heretofore lacked publicity.

MR. WILLIAM BARCLAY PARSONS, chief engineer of the subway, declares that if increase in the population of New York continues at its present rate, a new road with a carrying capacity as great as that of the completed subway will have to be built every four years.

MR. J. L. PUTNAM, general manager of the Clark Automatic Telephone Switchboard Company, Providence, R. I., has been laid up for a couple of weeks or more with inflammatory rheumatism, but we are glad to note that he is convalescing and expects to be on deck again soon.

MR. H. H. SINCLAIR, general manager of the Edison Electric Company, of Los Angeles, Cal., has left that city for a year's cruise through the South Sea Islands. He is accompanied by his family, on his boat, the "Lurline," the largest and fastest schooner-yacht on the Pacific Coast.

MR. H. HINE, formerly vice-president and general manager of the Stanley Electric & Manufacturing Company and now largely interested in the development of Mexican water power, being president of the Guanajuato Electric Light & Power Company, is again in New York at the Waldorf.

MR. G. F. METZGER, A. M. Inst. C. E., M. Inst. E. E., announces that having been appointed consulting engineer to the Manchester Corporation, England, for the completion of the work initiated by him as its city electrical engineer, he is now practicing as consultant in electrical and mechanical engineering at 3 York St., Manchester.

MR. JOHN H. KELMAN, for 14 years past prominently connected with the Stanley Electric Manufacturing Company at Pittsfield, Mass., and now superintendent, has resigned, and will at once, it is understood, join the electrical forces of the Allis-Chalmers Company, an important statement as to whose plans appears elsewhere in this issue.

MR. O. A. SANDBORGH has resigned his position as assistant electrical engineer with the Marine Engine & Machine Company, of Harrison, N. J., to accept an appointment with the Westinghouse Electric & Manufacturing Company at East Pittsburg, Pa., whither he has now proceeded from New York, where he has a wide circle of acquaintances.

MR. HERBERT W. SMITH, late of the Stuart-Howland Company, Boston, has associated himself with Mr. George H. Swazey under the firm corporate name of Swazey & Smith, with offices at 53 State St., Boston, and storeroom at Charlestown, Mass. They will furnish all material for lighting and railway plants and make contracts for complete equipments.

MR. REUBEN DUNELL, of D. H. Burnham & Company, the Chicago architectural engineers, has sailed for Europe for the purpose of creating a new department for J. G. White & Company, Limited, of London. The London concern intends to devote part of its attention to the construction of office and other buildings in the British metropolis and other parts of Great Britain.

MR. GEO. B. GORDON, of the Gramercy Exchange of the New York Telephone Company, has been appointed to an important position with the Chesapeake & Potomac Telephone Company, which controls the telephone system of Washington, D. C. Most of Mr. Gordon's time in his new position will be given over to supervising the installation of the common battery system, which the company is now adopting.

MR. CHAS. R. PRATT, who recently began independent practice as a consulting engineer, with offices at 160 Fifth Ave., New York, announces that he has associated with himself Mr. E. Van Winkle, a young engineer of considerable experience, who has been connected with the Otis Elevator Company, the Marine Engine & Machine Company and was lately the general manager of the National Coin Counting Machine Company.

MR. THOMAS J. JOHNSTON and Mr. George C. Dean have associated themselves for the practice of law with the firm name of Johnston & Dean, with offices at 11 Pine St., New York. Their specialties will be practice in the United States courts, particularly in equity; patent causes, proceedings in Admiralty, causes removed from State to Federal courts, customs cases, bankruptcy cases, etc. Both members of the firm have been admitted to the bar in many jurisdictions, and are well known practitioners.

MR. W. A. BIXBY.—This gentleman has become manager of the Quincy (Ill.) Gas and Electric Company. He has for some time past managed the lighting companies at Decatur, Ill. The capacity and output of the electric light plant there has been increased 25 per cent., and a heating plant has been built. Altogether in these three plants $200,000 has been invested in the four years. Mr. Bixby went into the lighting business at Nebraska City, Neb., in 1883. Since then he has held positions at Galena, Ill.; Little Rock, Ark.; Wichita, Kan.; Sherman, Tex.; Lorain, O.; Champaign and Decatur.

DR. G. F. KUNZ.—Dr. George F. Kunz, of New York city, special agent of the United States Geological Survey, has been appointed Commissioner of the radium exhibit at the St. Louis Exposition, and has been authorized to prepare and procure material therefor, comprising radio-active substances of all kinds, and also exhibits to illustrate the action of radium compounds, ultra-violet light, and Roentgen rays upon mineral and chemical substances. This exhibit is to be made by the United States Geological Survey in the United States Government Building at St. Louis. There will be a second exhibit of radium and radio-active substances in the Mines Building.

MR. CARLOS G. PALACIOS, the head of the electrical department of the Caracas Gas & Electric Light Company, Caracas, Venezuela, is now here for the purpose of investigating the latest equipment, purchasing same, and determining what shall be installed in several water power and steam-driven plants about to be constructed or added to in that South American country. Mr. Palacios some twenty years ago was connected with the old United States Electric Light Company. He was the first to introduce American electrical machinery into Venezuela, where he has installed numerous plants. He may be found at the offices at 79 and 81 Wall St. of Kates & Bok.

MR. JOHN McGEORGE, consulting engineer of the Wellman-Seaver-Morgan Company, has resigned, the change to take effect March 1. He has been connected with the Wellman interests as mechanical engineer for over 13 years. After March 1, he will be located at No. 501 Citizens Bldg., Cleveland, O., having opened an engineering office, under the name of McGeorge & Sons, taking into partnership with him his sons. He expects to do general consulting business, paying particular attention to power plants and the engineering side of office buildings. Mr. Ernest McGeorge, at present with the Wellman-Seaver-Morgan Company, will resign at the same time to become a member of the new firm.

MR. W. S. LAYCOCK, the large British contractor for railroad fittings, supplies, etc., who has introduced a number of American devices, including the Gold electric car-heating apparatus, for use on British, Colonial and Continental European railroads, is now on a visit to this side. He intends to make arrangements while here for electric car-lighting equipment for use on British steam roads. Mr. Laycock's plant, the Victoria Works, Millhouse, near Sheffield, is the only one on the other side which is completely equipped with Yankee machinery—Brown & Sharpe, Pratt & Whitney, etc.—and driven by electric power. It cost nearly $500,000. Mr. Laycock is accompanied by Mr. George A. Wyld, his chief engineer. They are guests at the Waldorf-Astoria.

MR. SAMUEL S. DICKENSON.—We are glad to note that Mr. Samuel S. Dickenson has been brought to New York city to assume the newly created position and office of general superintendent of the Commercial Cables. This well-known, estimable and highly competent electrical engineer has been connected with the Atlantic Cable service since 1874. He established and has been the superintendent of the Commercial Cable Company's important station at Hazel Hill, Canso, Nova Scotia, since 1884. His technical knowledge and capacity for practical affairs made him extremely valuable in his regular occupation, and marked him as a specially suitable official to employ on such vital work as the selection of landing places and the establishment of new stations whenever the company required services of that delicate nature. Thus he was sent by Mr. Ward to the Azores in 1900 to select a landing place and to create its station at Horta, Fayal, for the Canso-Fayal cable. This cable placed the Azores and North America in direct telegraphic communication for the first time; and for his services in connection with the event, the King of Portugal decorated him with a distinguished military order. When, in 1901, the Commercial Pacific Cables were planned, he was again sent by Mr. Mackay and Mr. Ward to select landing places at Honolulu, Midway, Guam and Manila. He also established the office at Honolulu. The new office which he has come to New York to direct was made necessary by the increasing amount of executive work growing out of the development of the company's business, and which his admirable qualifications make him eminently capable of filling.

## Trade Notes.

WESTINGHOUSE BALTIMORE OFFICE.—The Baltimore office of the Westinghouse Electric & Manufacturing Company has opened temporary quarters at 221 North Calvert Street.

OBERG & BLUMBERG, contracting electrical engineers, have removed their offices in New York city from 853 Broadway to 112-114 West Forty-second St. and 107-117 West Forty-first St.

BULLOCK ELECTRIC MFG. CO., of Cincinnati, O., has issued very appropriately for its portrait calendar for February, one bearing the portrait and biography of Mr. T. A. Edison, whose birthday falls on the eleventh day of the month. He was born in 1847.

THE CHICAGO FUSE WIRE & MFG. CO., Chicago, New York and Buffalo, is drawing attention to a new line of switch outlet boxes which it is now prepared to furnish. Special attention is called to the fact tha this box is made to take any of the best makes of rectangular push-button switches and flush receptacles in common use.

THE EUREKA COMPANY, Chicago and Genoa, Ill., is now prepared to furnish its new Bell style self-restoring ring-down switchboard on which it has been favored with many orders recently. This drop has met with universal favor with telephone engineers, and is a new departure from the regular restoring drops. Its new bulletin on this new board is now ready and it would be pleased to forward same upon receipt of notice.

REMOVAL.—The American Conduit Manufacturing Company announces that its main office has been moved from New Kensington to Pittsburg, Pa. The better facilities for communication thus obtained will enable the company to render better service to its patrons than before. The company invites all interested in conduit work to call on it at its new quarters. New improvements completed at the New Kensington factory, the company states, has enhanced the superior qualities of American conduit. The new office address is 413 Grant St., Pittsburg.

THE CENTRAL ELECTRIC COMPANY is sending out a circular which quotes some very attractive prices on American Circular Loom flexible conduit, for which it is sales agent. The company especially requests that any one who is in the market for this class of material should write for quotations. Attention is also called to the fact that the Central Electric Company is sales agent for Edison primary batteries, formerly known as Edison-Lalande batteries. The company carries a complete stock of these batteries and is prepared at all times to make prompt delivery.

RAND DRILLS.—Contradicting the suggestion of a slackening of business activities comes the report that the "Imperial" pneumatic tool department of the Rand Drill Company telling of the large increase of sales since the first of the year. That the sterling worth of its products is universally appreciated is proven by the orders received for piston air drills, Wood boring machines and hammers and the installation of a number of complete pneumatic tool plants in the railroad shops, ship yards, boiler works, foundries and bridge and iron works, both in this and in foreign countries.

THE ALUMINO-THERMIC PROCESS.—The Goldschmidt Thermit Company has been formed as a corporation under the laws of the State of New York, for the purpose of exploiting in the United States of America the alumino-thermic process invented by Dr. Hans Goldschmidt and protected by United States patents. It is proposed to conduct business generally in connection with the Chemical and Tin Smelting Works of Th. Goldschmidt, Essen-Ruhr, Germany (founded 1847), and the company is prepared to handle all products dealt in by the parent concern. Offices have been secured at 41 Wall St., New York

THE EMERSON ELECTRIC MFG. CO, of St. Louis and New York, has just issued for 1904 a very handsome and striking catalogue of its fan motors, so well known all over the world. The cover is dark gray embossed in red, gold and black, and shows a standard fan motor in high relief on a wall bracket. The contents are more extensive and detailed than in previous years, and enter very fully into the construction and design of its various types for high and low-frequency work. The various fan motors are illustrated complete and sectionally, and the careful descriptive text is admirable. All told, there are 62 small square quarto pages in this compendium of the alternating fan motor art.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., reports that it is enjoying great success in meeting the demands of the machine tool trade for controllers for use with variable speed motors, the speed variation being obtained by varying the field strength. The motor starter and field rheostat are so interlocked that the motor cannot be started under condition of weak field, and the fact that its field rheostats have a large number of points for control and its starter has an overload device which operates during the period of starting and the no-voltage release magnet is independent of the field strength, seem to have fulfilled the demands of the machine tool trade. It would be glad to cooperate with any machine tool manufacturer in filling his demands.

LOCKE INSULATORS.—As has recently been exemplified and illustrated in this journal, a number of interesting new designs of high-grade insulators have been brought out and put on the market by the Locke Insulator Company, Victor, N. Y. We learn from Mr. Fred M. Locke, the president, that the company has lately considerably increased its facilities for handling small porcelain work, and desires acquaintance with the requirements of engineers and electrical manufacturers. Inasmuch as the Locke porcelain has been very highly developed for high voltage work, this should be of interest to all porcelain users. Its last publication, Booklet No. 7, is now being mailed, and will be sent on request to any one interested. The list of the large enterprises using these insulators is a long and convincing one.

OTTO WEISS MACHINE DEPARTMENT of the Chase Machine Co., of Cleveland, Ohio, writes us as follows through Mr. Thomas A. Aiton, manager: "We manufacture machinery used for forming electric wires and cables and for insulating the same. We manufacture a large range of these machines for all kinds of insulation from silk to lead. I worked from some four years in Berlin, Germany, as assistant to Mr. Otto Weiss, who was for many years the head engineer at Siemens Bros., London, and who manufactured and laid a great number of submarine cables. Later he established his own company in Berlin, for the manufacture of machines used in this line of work. Perhaps it would interest you to know that I have just placed a 4-head cabling machine with the Waclark Wire Co., at Bay Way, N. J. This machine is 96 inches long and weighs 55,000 pounds, and is used for making 61-wire strands up to two million circular mills. We have also placed several of these machines, as likewise similar ones though smaller, in many of the wire and cable works of this country."

PERFECT WINDOW LIGHTING.—Among the many methods of making a store-front attractive, well-lighted windows undoubtedly take first place. There can be no question as to what constitutes the best form of window lighting. The source of light must be hidden from view, yet the fullest illumination must be obtained from the lamps. This has become possible through the Frink system of lighting as embodied in the special patent window reflector of I. P. Frink, 551 Pearl St., New York. The reflector is composed of silvered corrugated glass set in a metal frame, designed on scientific lines so that all the light is reflected on the goods, yet is hidden from the sidewalk. Nothing is more annoying to an intending purchaser than to have his view of goods in a window blurred by the glare of electric lights. Progressive electricians are much interested in this subject and many have taken advantage of their opportunity by equipping the stores of their customers with Frink reflectors. A request to the above address will bring full information and estimate on the next store-lighting contract that any of our readers in the lighting field may have before them.

POOR'S MANUAL OF RAILROADS, recently issued, is considerably larger than any previous issue and correspondingly more complete in its scope and contents, returns of all leading railroads for the year ending June 30, 1903, or later, that were received up to Nov. 1, 1903, being included in its pages. Compared with the Manual for 1902, the current issue increased in the Department of Steam Railroads from 846 to 880 pages, the number of corporations for which statements are presented being 2,043 this year, against 1,937 in 1902. In the section devoted to statements of city and suburban railways, the number of corporations reported in 1903 is 1,177; in 1902, 1,156. The number of pages in this section is 257 in 1903, against 239 in 1902. In the department of miscellaneous industrial corporations, statements are presented for 236 enterprises against 199 in 1902. To provide space for this expansion in the scope of that department called for an increase of 32 pages, the Manual for 1903 devoting 145 pages to the presentation of statements of the affairs of "Industrials," against 113 pages in the previous issue of the book. It would be hard to find a more valuable statistical production than this as to financial investments and opportunities in the traction and industrial fields.

# Record of Electrical Patents.

UNITED STATES PATENTS ISSUED FEBRUARY 2, 1904.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., New York.]

750,793. SELECTIVE SIGNALING SYSTEM; Garrison Babcock, Chicago, Ill. App. filed July 17, 1903. (See page 326.)

750,807. TELEGRAPH APPARATUS; John E. Carney, Montgomery, Ala. App. filed Feb. 24, 1903. A telegraph instrument comprising a permanent magnetic system having one of its poles divided into two pole pieces, and armature being pivoted on one of said pieces and free to play between the remaining two pieces; a winding modifies the action of the system.

750,811. OIL-SWITCH; William H. Cole, Watertown, Mass. App. filed April 29, 1903. The invention relates principally to a non-porous plug through which the conductors lead into the oil casing and which prevents escape of the oil along the conductors.

750,818. TROLLEY HARP OR FORK; Fred P. Crockett and Osro P. Johnson, Kalamazoo, Mich. App. filed April 4, 1903. Details.

750,825. AUTOMATIC TROLLEY LINE REEL; Charles F. Davy, Mohawk, N. Y. App. filed March 19, 1903. A spring drum and ratchet for retracting the trolley pole.

750,835. TELEPHONE-TRANSMITTER; Ernest B. Fahnestock, New York, N. Y. App. filed Dec. 2, 1901. (See page 325.)

750,845. SWITCHING APPARATUS; John S. Goldberg, Chicago, Ill. App. filed Nov. 26, 1902. Details of a ringing and listening key.

750,873. INSULATING SLEEVE AND METHOD OF MAKING SAME; Norman Marshall, Newton, Mass. App. filed June 6, 1902. A cylindrical insulating sleeve having its ends of different diameters and having a seam running its full length with abutting edges intimately shaped to each other.

750,876. ELECTRIC PLANT FOR CHARGING STORAGE BATTERIES; Joseph B. Meriam and Mark B. Crist, Cleveland, O. App. filed July 25, 1902. The plant consists of a gas engine, a dynamo adapted to be operated as a motor for starting the engine, a switch by which the motor is supplied with current from a battery temporarily for starting the engine and mechanism whereby the engine will drive the dynamo and be automatically stopped when the battery is fully charged.

750,894. ELECTRIC ARC LAMP; Joseph A. Rignon, Berlin, Germany. App. filed April 11, 1902. Two carbons are mounted upon corresponding arms of bell cranks, the other arms of which are connected with the core of the solenoid; the carbons converge and are brought together and separated by the solenoids.

750,938. ALTERNATING CURRENT WATTMETER; Charles A. Brown, Chicago, Ill. App. filed July 24, 1900. The windings of the meter, one for pressure and the other for current, are superposed, whereby the fields produced thereby are collocated.

750,939. PROCESS OF MEASURING WATTS IN ALTERNATING-CURRENT CIRCUITS; Charles A. Brown, Chicago, Ill. App. filed Nov. 19, 1900. The process consists in creating a single field by the current and pressure in the system and subjecting a measuring element to the action of said field.

750,940. ALTERNATING-CURRENT MOTOR; Charles A. Brown, Chicago, Ill. App. filed July 13, 1903. A combination between two energizing circuits serving to carry currents adapted to produce magnetic flux following the same path, and an armature carrying a short-circuited winding in inductive relation to said circuits.

750,947. ELECTRIC CONTROLLER; Frank E. Case, Schenectady, N. Y. App. filed Sept. 16, 1901. Relates to the arc-extinguishing and deflecting devices in a car controller.

750,948. DEMAND DISCOUNT METER; Frank P. Cox, Lynn, Mass. App. filed Aug. 15, 1902. Means for changing the speed of the meter so long as the line current exceeds a predetermined maximum.

750,953. PLUG-EJECTING JACK FOR TELEPHONE-SWITCHBOARDS; Robert G. Dunfee, Fostoria, Ohio. App. filed June 6, 1902. (See page 325.)

750,966. SURFACE-CONTACT ELECTRIC RAILWAY; John H. Guest, Brooklyn, N. Y. App. filed Feb. 26, 1903. Improvements in sectional conductor systems wherein an electro-magnet is first energized by a light current to close the circuit to a section and afterwards maintained in an energized condition by the power current.

750,971. SWITCH FOR SERIES ARC CIRCUITS; Caryl D. Haskins, Schenectady, N. Y. App. filed Aug. 22, 1902. A movable diamond-shaped contact device co-operating with spring contacts for the purpose of making the lamp connections before breaking the circuit connections, and *vice versa*.

750,972. MEANS FOR CONTROLLING ELECTRIC BOOSTERS; Edward M. Hewlett, Schenectady, N. Y. App. filed Aug. 31, 1900. A cut-out in the booster circuit is actuated automatically when the motor which drives the booster ceases to operate.

750,980. FIELD-COIL STRUCTURE; Charles H. Kaler, Schenectady, N. Y. App. filed Aug. 5, 1902. Ventilating spaces are provided in a coil by inserting blocks of wood between sections of the winding.

750,991. RAILROAD SIGNALING DEVICE; Joseph R. Marchesseault, Meriden, Conn. App. filed Nov. 13, 1902. Details.

750,993. ELECTRIC SWITCH; George Monson, Schenectady, N. Y. App. filed July 25, 1901. The blade is forked at the end and passes over the outside of two spring clips.

751,003. CONTROLLER CASING; Charles L. Perry, Schenectady, N. Y. App. filed Oct. 26, 1900. A latch for securing the cover of the controller casing.

751,012. FUSE BOX; Robert H. Read, Schenectady, N. Y. App. filed April 1, 1901. Venting channels communicate with the passage containing the fuse and terminate in metal mesh which relieves the escaping gases of heat.

751,013. SIGNAL DEVICE FOR SEARCH-LIGHT PROJECTORS; Robert H. Read, Schenectady, N. Y. App. filed Aug. 3, 1901. The casing surrounding the carbons swings on a center coincident with the axis of the carbon, for the purpose of covering and uncovering the light.

751,015. ELECTRICAL MEASURING INSTRUMENT; Lewis T. Robinson, Schenectady, N. Y. App. filed Feb. 10, 1902. The parts are so related that the magnetic return-piece or counter-torque element, in shifting from a position of maximum flux to a position of minimum flux, will cover an angle greater than 90°, resulting in an effective scale angle exceeding 60°.

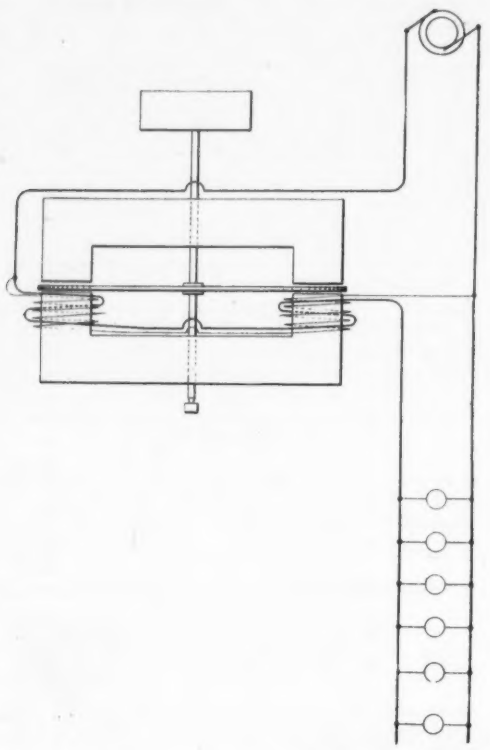
751,021. AUTOMATIC SIGNALING SYSTEM FOR ELECTRIC RAILWAYS; Harry B. Snell, Cement City, Mich. App. filed April 25, 1903. Details of a signal switch actuated by the trolley wheel.

751,025. ELECTRIC ARC LAMP; George E. Stevens and Walter C. Fish, Lynn, Mass. App. filed June 14, 1902. For the purposes of low cost and simplified construction the lamp is largely constructed of porcelain and punched metal fittings.

751,029. LAMP SOCKET; Julius C. Tournier, Schenectady, N. Y. App. filed April 30, 1900. Details.

751,046. PLATE FOR STORAGE BATTERIES; Joseph Bijur, New York, N. Y. App. filed March 31, 1902. (See Current News and Notes.)

751,048. SIGNAL SYSTEM FOR ELECTRIC RAILWAYS! Charles P. Breese, Norfolk, Va., and Adoniram J. Wilson, Westfield, N. J. App. filed May 5, 1902. Details.



750,939.—Process of Measuring Watts in Alternating-current Circuits.

751,071. SIGNALING APPARATUS; Edwin L. Grauel, Rochester, N. Y. App. filed March 19, 1903. Relates to the construction of make-and-break signaling apparatus for calling upon the relays of telegraph lines when it is desired to annunciate a rapid, steady and extended signal.

751,084. ELECTRIC SWITCH; Ernest A. Lowe, Plainfield, N. J. App. filed Jan. 17, 1902. A construction for obtaining strength in a switch blade which has mechanically attached to it and in the circuit an inclosed fuse.

751,100. ELECTROMAGNETIC ORE SEPARATOR; Ellen M. Oviatt and Alexander Dean, Denver, Colo. App. filed May 3, 1901. Details.

751,103. TELEPHONIC CALL INSTRUMENT; John D. Peachy, East Orange, N. J. App. filed Jan. 6, 1903. (See page 325.)

751,120. ELECTRICAL CONTROLLER AND BRAKE-OPERATING DEVICE; Walter W. Tice, Rahway, N. J. App. filed April 7, 1903. Details.

751,150. ELECTROMAGNETIC ORE SEPARATOR; Alexander Dean, Denver, Colo. App. filed Dec. 13, 1902. Wedge-shaped pole pieces overlapping each other, and over which the ore-carrying belts travel, are provided with adjustments for determining their relative position.

751,163. FEED WHEEL FOR AUTOMATIC TELEGRAPHIC PERFORATORS AND TRANSMITTERS; John Gell, London, England. App. filed March 17, 1903. The pins for drawing along the tape are carried by a sleeve which is slipped over the feed wheel and is adjustable to make the pins register accurately with the perforations in the tape.

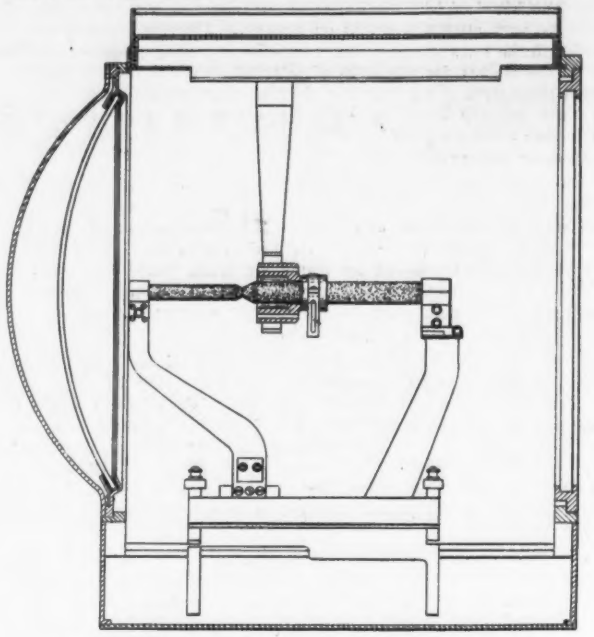
751,170. PROCESS OF ELECTROLYTICALLY PURIFYING JUICES. Alexander Knollrepp, Berlin, and Alfred Wohl, Charlottenburg, Germany. App. filed June 10, 1902. (See Current News and Notes.)

751,174. ELECTRIC SWITCH; William F. Irish, East Orange, N. J. App. filed July 23, 1902. Details.

751,175. THIRD RAIL FOR ELECTRIC RAILWAYS; Lloyd G. Johnstone, New York, N. Y. App. filed Oct. 10, 1903. The rail is covered by a metal plate supported on springs, and adapted to be forced downward by the shoe on the car to obtain the necessary contact.

751,191. ELECTRIC MOTOR; Hiram P. Maxim, Pittsburg, Pa. App. filed March 12, 1903. A motor frame comprising two cylinders and two end plates clamped together and completely inclosing the armature, the field-magnet pole pieces and coils and the commutator.

751,193. ELECTRICAL ALARM DEVICE; Burnett Menkin, Philadelphia, Pa. App. filed July 30, 1901. The invention comprises normally-open first and second circuits, in the latter of which the alarm is included, means for making and breaking the first circuit, a movable contact device for closing the second circuit and automatically breaking the first, and a switch for breaking the second circuit.



751,013.—Signal Device for Search-light Projectors.

751,227. ELECTRIC CUT-OUT; William H. Verner, Pittsburg, Pa. App. filed Aug. 28, 1902. Details.

751,228. CABLE HANGER; Richard H. Villard, New York, N. Y. App. filed Aug. 5, 1902. A strap with clamping-hook.

751,271. APPARATUS FOR HEATING AIR OR LIQUIDS TO A CONSTANT TEMPERATURE; Victor Eltz, Abbazia, Austria-Hungary. App. filed June 18, 1902. An expansible liquid automatic circuit controller.

751,294. APPARATUS FOR ELECTRICALLY TRANSMITTING AND RECEIVING MESSAGES; Arthur T. M. Johnson, Highbury, England. App. filed June 6, 1902. A transmitting instrument having a secondary winding, and means for producing impulses therein at different rates, a number of receivers each operated by impulses of two different rates, one of which is common to all the receivers and the other specific to the particular receiver.

751,298. TROLLEY; John Kelly, Pittsburg, Pa. App. filed July 11, 1903. The lessening of pressure of the wheel on the wire throws up guard arms which prevent the wheel from actually leaving the wire.

751,304. ELECTRIC VACUUM DISCHARGE TUBE; Michel Krouchkoll, Paris, France. App. filed May 26, 1902. A bunch of glass fibre or capiliary tubes contained in the X-ray tube serves to retain a certain amount of gas by which the vacuum is regulated.

751,321. ELECTRIC LIGHT FIXTURE; John J. Miller, Pittsburg, Pa. App. filed May 21, 1903. Incandescent lamps are arranged upon a horizontal rail to be slid along the same to bring the light to the most advantageous position.

751,344. TELEPHONE-RECEIVER; Lewis Sands and Charles C. Cadden, Cleveland, Ohio. App. filed March 6, 1903. (See page 325.)

751,304.—Electric Vacuum Discharge Tube.

751,353. ELECTRIC BLANKET; Frank K. Singer, Wheeling, W. Va. App. filed Sept. 8, 1903. A heating resistance is distributed throughout the blanket.

751,354. INSULATED WIRING TACK; Donald G. Smart, Grand Rapids, Wis. App. filed Jan. 5, 1903. An insulating plate is adjusted under the T-head of a tack to prevent cross-connecting the two wires of the circuit that may be caught under the head of the tack.

751,362. THERMOSTAT; John L. Ward, Ord, Neb. App. filed July 9, 1903. An expanding rod moves an index finger over a scale until it touches a contact, when an alarm is sounded.

751,363. PRINTING TELEGRAPH RECEIVER; James D. White, London, England. App. filed June 19, 1903. Details.

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**"AMERICAN"**

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AMERICAN BATTERY CO.

172 So. Clinton St., Chicago, Ill.

Established 1889.

ELECTRIC, SOLDERING, LAUNDRY, POLISHING, TAILORS' IRONS, GLUE POTS, BROILERS, TOASTERS, GRIDDLES, OVENS, STOVES, CURLING IRON, HEATERS, Etc.

**IT IS PROBABLY A FACT**

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DETROIT, MICH. 4

**The ALLEN Soldering Stick does the business**

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BIG STICK 10 CENTS.

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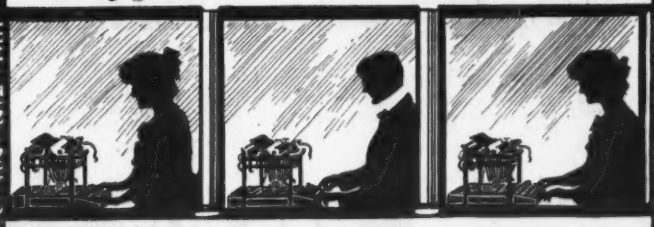

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Where the need for strength and reliability is greatest,
There you will always find the

**Remington**

REMINGTON TYPEWRITER CO., 327 Broadway, N. Y.

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*The rate for "Position Wanted" advertisements of forty words or less is one dollar an insertion; additional words two cents each, payable in advance. Remittance and copy should reach this office not later than Tuesday morning for the next succeeding issue.*

POSITION WANTED.—Where ability and study of employer's interest will be rewarded with advancement, by technical graduate in electrical engineering, with eight years' experience in operation of electric lighting and street railway business; able to take charge of commercial side of either; salary at start no object with right concern; references by present employers; married and of good address. Address No. 1284, care Electrical World and Engineer, New York.

POSITION WANTED.—As manager or superintendent; fourteen years' practical experience installing and operating light and power plants, water power and steam. Address No. 1282, care Electrical World and Engineer, New York.

POSITION WANTED.—By electrical engineer, college graduate; extensive experience installing and operating electric light and power plants, pole line construction, house wiring, meters, etc.; able mechanic and armature winder; prefer installing or superintendent of lighting plant. Address No. 1288, care Electrical World and Engineer, New York.

POSITION WANTED.—By a young man, 33, having experience of 12 years in the electric light business, holding position of bookkeeper, cashier, secretary and local manager, is open for an engagement; best of references. Address No. 1305, care Electrical World and Engineer, New York.

POSITION WANTED.—By a young technical graduate in any branch of electrical engineering work where there is a chance for advancement; prefer a position in or near New York; can furnish good references. Address No. 1307, care Electrical World and Engineer, New York.

POSITION WANTED.—By a young man, 20 years old, graduate International Correspondence Schools, Scranton, Pa.; would like a position as mechanical draftsman with good concern, electrical preferred, with good prospect of advancement; no objection to low salary; good references. Address No. 1308, care Electrical World and Engineer, New York.


YOU NEED IT!

GALE'S COMMUTATOR COMPOUND.

Gale's Commutator Compound

The only Article that will Prevent Sparking

Will keep the commutator in good condition and prevent cutting. Absolutely will not gum the brushes. 50c. per stick. $5.00 per dozen. *Send 50c. for trial stick.*

FOR SALE BY ALL SUPPLY HOUSES, OR (1)

K. McLENNAN & CO. SOLE MANUFACTURERS 909, 100 Washington Street, CHICAGO

IF YOU WANT AN ARTICLE THAT WILL REPEAT ITSELF, TRY

U. S. METAL POLISH

FOR POLISHING ALL KINDS OF METALS.

Sold by Dealers. Samples Free. Geo. W. Hoffman, MANUFACTURER 295 E. Washington St., Indianapolis, Ind.

WHY DON'T YOU —— Put a Little

Hare's Commutator Compound

on that Sparking Motor, and save the Commutator? Save your time too. Both cost money.

Big Stick, 35c. Enough to show you FREE.

SOUTHWORTH & HARE, Indianapolis, Indiana

MECHANICAL DRAWING AND DESIGN

$3 Postpaid

Do you want to thoroughly master the principles and practice of Drawing and Designing as required in the shops and drafting rooms of the engineering, electrical, machinery and kindred trades? If so, send for **Rogers' Drawing and Design.** a practical and complete self-instructor for home-study.

506 pages, 610 illustrations. Clearly printed on superfine paper and handsomely bound in black vellum cloth, with full gold edges. *The money paid will be refunded if the book is not found to be satisfactory.*

THEO. AUDEL & CO., Educational Book Publishers, 63 Fifth Ave., New York

Specimen pages and a complete list of contents sent postfree upon request


POSITION WANTED.—By A1 armature winder and repair worker on motors, generators, commutators, field, etc.; can locate trouble and work without assistance; railroad company preferred; 18 years experience, with best of references. Address No. 1306, care Electrical World and Engineer, New York.

POSITION WANTED.—By young man, technical graduate with 8 years practical experience in all kinds of wiring for lighting and power apparatus; thoroughly understands all kinds of testing, good draughtsman, handy with all kinds of machine tools and piping; desires steady situation. Address No. 1312, care Electrical World and Engineer, New York.

POSITION WANTED.—As superintendent or manager of lamp factory, by a practical lamp maker of 16 years experience. Address No. 1310, care Electrical World and Engineer, New York.

POSITION WANTED.—With engineering, contracting or power company, by energetic married American man of good report and well recommended; 15 years experience in construction, erecting, estimating, etc. Familiar with steam and water power. Address No. 1314, care Electrical World and Engineer, New York.

POSITION WANTED.—As general manager or superintendent of electric light or power plant; have had 15 years practical experience; would make proposition to take charge of a property on a percentage basis with nominal salary. Address No. 1313, care Electrical World and Engineer, New York.

POSITION WANTED.—By experienced bookkeeper, 28 years of age; at present employed as bookkeeper and cashier for electric light and power plant; experienced in reading meters. Address Box 437, Georgetown, S. C.

POSITION WANTED.—A first-class solicitor for light and power is open for a position; am capable of taking charge of commercial end; I use demand system of charging; will guarantee to increase receipts without materially increasing operating expenses or capital account. Address No. 1302, care Electrical World and Engineer, New York.

(*Continued on page 47.*)

## ALTERNATING GENERATORS.

60 CYCLES.

1100 or 2200 volts, 7200 Alternations.

| Lt. | | Speed. |
|---|---|---|
| 2 | 300 Gen. Elec., 15-K.W., comp., single phase, with exciter | 720 |
| 1 | 500 Wood, 25-K.W., comp., iron clad armt., single phase, with exciter | 720 |
| 1 | 600 West., 30-K.W., comp., toothed iron clad armt., single ph., with exciter | 825 |
| 1 | 750 Wood, 37½-K.W., comp, iron clad, armt., single phase, with exciter | 525 |
| 1 | 900 West., 45-K.W., comp., toothed armt., 2 phase, 1100 v., with exciter | 720 |
| 1 | 1200 West., 60-K.W., toothed armt., single ph., comp., with exciter | 720 |
| 1 | 1500 Warren-Medberry, 75-K.W., 2 ph., ind. type, with exciter, 2200 v. | 600 |
| 1 | 1500 Stan., inductor, 75-K.W., 2 phase, 1100 or 2200 v., with exciter | 900 |
| 1 | 1500 West., 75-K.W., comp., distributed winding, 2 ph., 1100 v., with exciter | 900 |
| 2 | 1500 West., 75-K.W., 2 ph., 2200 v., d. c. to 14x14 Gates 4-valve aut., engine, complete with exciter | 300 |
| 1 | 1500 Wood, 75-K.W., comp., slotted armt., with exciter | 600 |
| 1 | 2400 Gen. Elec. 120-K.W., 3 phase, 2200 or 3300 v., with exciter | 600 |

## 125-133 CYCLES ALTERNATING GENERATORS.

| Lt. | | Speed. |
|---|---|---|
| 1 | 650 Wood, 33-K.W., comp., | 1680 |
| 1 | 750 West., 37½-K.W. | 1650 |
| 1 | 750 Wood, 37½-K.W., comp. | 400 |
| 1 | 900 Warren-Medberry, 45-K.W., inductor type | 1300 |
| 1 | 1000 Wood, 50-K.W., comp. | 1400 |
| 2 | 120 West., 60-K.W., toothed armt., comp. | 1650 |
| 1 | 1500 Wood, 75-K.W., comp. | 1050 |
| 1 | 1500 Stanley, inductor type, 75-K.W., 1100 or 2200 v., 2 phase | |
| 1 | 1800 West., 90-K.W., comp., toothed armt. | 1500 |
| 1 | 2400 Gen. Elec., 120-K.W., type A 120, latest type, comp., toothed armt | 1070 |
| 2 | 2400 Gen. Elec., 120-K.W., type A S, comp., slotted armt. | 1070 |

# LATEST TYPES OF (second-hand) ELECTRICAL MACHINERY

FOR SALE AT BARGAIN PRICES

# GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing complete list of apparatus with NET PRICES. All machines fully guaranteed.

| Lt. | | Speed. |
|---|---|---|
| 2 | 2400 West., 120-K.W., comp., self-oiler, toothed armt. | 1375 |
| 1 | 4000 Stan., inductor type, 200-K.W., 1100 or 2200 v., 2 phase | 670 |
| 1 | 8000 West., 400-K.W., slotted armt., 3 bearings, distributed windings | 445 |

## 110 TO 125 VOLT GENERATORS.

DIRECT CURRENT.

| Lt. | | Speed. |
|---|---|---|
| 4 | 10 West. Elec., M. P. | 1350 |
| 1 | 25 Triumph, M. P., comp. | 1400 |
| 1 | 35 Crocker-Wheeler | 1200 |
| 3 | 40 Gen. Elec., type I B | 1900 |
| 1 | 45 Excelsior, M. P. | 900 |
| 3 | 45 West., M. P., comp. | 1800 |
| 1 | 45 Gen. Elec., type C E | 2050 |
| 1 | 50 Crocker-Wheeler | 1150 |
| 1 | 50 C. & C., comp., self-oiler | 1550 |
| 1 | 50 Northern, M. P. | 2100 |
| 3 | 55 Edison, self-oiler, 3-K.W. | 1900 |
| 2 | 60 Hobart, M.P., comp., s-o. | 1200 |
| 1 | 75 Hobart, M.P., comp. | 1300 |
| 2 | 75 West., M. P., comp. | 1650 |
| 1 | 80 Riker, M. P., comp., s-o. | 1100 |
| 1 | 80 New Eng., multipolar | 1450 |
| 1 | 80 Perrett, multipolar | 950 |
| 2 | 80 Card, multipolar | 1250 |
| 1 | 80 Crocker-Wheeler, comp. | 1350 |
| 1 | 100 Card, M. P. | 1000 |
| 2 | 100 Hobart, M. P., comp. | 1500 |
| 2 | 100 Northern, M.P., comp. | 1600 |
| 2 | 100 Com., M. P., comp. | 1350 |
| 1 | 150 Eddy, M. P. | 1650 |
| 1 | 120 West. Elec., M.P., comp. | 750 |
| 1 | 180 Triumph, M.P., comp. | 1200 |
| 1 | 210 Triumph, M.P., comp. | 1100 |
| 1 | 210 Eddy, M. P. | 1100 |
| 1 | 210 Sprague-Lundell, M. P., | 1050 |
| 1 | 210 Crocker-Wheeler, M. P. | 1000 |
| 2 | 210 Edison, s-o., 12-K.W. | 1500 |
| 1 | 250 Fuller, M. P., comp. | 580 |
| 1 | 300 Perrett, M. P., comp. | 750 |
| 1 | 300 Phoenix, M. P. | 1100 |
| 1 | 300 Ahlms-Edwards, M. P. | 825 |
| 2 | 350 Edison, 20-K.W., comp. | 1400 |
| 2 | 350 C. & C., M.P., 20-K.W. | 800 |
| 1 | 350 Card, M.P., comp. | 800 |
| 1 | 400 Crocker-Wheeler, M. P. | 1150 |
| 1 | 400 Triumph, M. P., comp. | 950 |
| 1 | 400 Crocker-Wheeler, M. P. | 875 |
| 1 | 400 Northern, 22½-K.W. | 1000 |
| 2 | 450 Edison, 25-K.W., s-o. | 1300 |
| 1 | 450 Gen. Elec., M. P., comp. | 1100 |
| 1 | 450 Sprague-Lundell, M. P. | 925 |
| 1 | 540 C. & C., M.P., 30-K.W. | 700 |
| 1 | 540 Fisher, M.P., comp. | |
| 2 | 540 Gen. Elec., M.P., comp. | 1000 |
| 3 | 600 Card, M.P., comp. | 850 |
| 2 | 700 Commercial, M. P., comp. | 865 |
| 1 | 750 Card, M. P., comp. | 750 |
| 2 | 800 Edison, 45-K.W., comp. | 1000 |
| 1 | 900 Wagner, M. P., comp. | 950 |
| 2 | 1000 Edison, s-o., 60-K.W. | 700 |
| 1 | 1300 Walker, M. P., 75-K.W. | 600 |
| 1 | 1300 Card, M. P., comp. | 500 |
| 1 | 1800 Edison, 100-K.W., s-o. | 650 |

## DIRECT CONNECTED UNITS

| Lt. | | Speed. |
|---|---|---|
| 1 | 100 G. E., 6 pole, comp., d.s. to 12x13 Weston aut. engine, 60-K.W., 125 v. | 275 |
| 1 | 1350 Waddel-Entz, 80-K.W., d. c. to Ball engine, 15x14, 125 v. | 265 |
| 1 | 1350 Ft. Wayne, comp. d. c. to 13x14 Buckeye vert. engine, 80-K.W., 125 v. | 275 |
| 2 | 130 Gen. Elec., M. P., 6 pole shunt, d. c. to Ames tandem comp. 11x17x12 aut. engine, 12 v. | 270 |
| 1 | 2500 West. Elec., M.P., comp. for d.c., brand new, 150-K.W., 125 v. | 240 |
| 1 | 40 Commercial, M.P., d.c. to 11x12 aut. Chandler-Taylar engine, 250 v. | 300 |
| 1 | 75 Siemens & Halske, Churchward type, M.P., brand new, for d. c., 250 v. | 300 |
| 2 | 75 West., 60 cycle, 2 phase, 2200 v., d. c. to 14x14 Gates 4-valve aut. engine, complete with exciter | 300 |

## 220 TO 250 VOLT GENERATORS.

| K.W. | | Speed. |
|---|---|---|
| 1 | 12 Crocker-Wheeler, M. P. | 1000 |
| 1 | 12 Card, M. P., comp. | 800 |
| 1 | 12 Westinghouse, M. P. | 1400 |
| 1 | 15 Edison, self-oiler | 1400 |
| 1 | 20 Western Electric | 150 |
| 1 | 20 Edison, self-oiler, comp. | 1400 |
| 1 | 20 Wagner, multipolar | 1200 |
| 1 | 20 Keystone, M. P., comp. | 950 |
| 1 | 20 Eddy, M. P., comp. | 950 |
| 1 | 20 Diehl, M. P., comp. | 925 |
| 1 | 25 Crescent, multipolar | 1000 |
| 1 | 25 Commercial, s-o, comp. | 1380 |
| 1 | 30 Western Elec., M. P. | 600 |
| 1 | 30 Triumph, M. P., comp. | 950 |
| 1 | 37½ Keystone, M. P., comp. | 800 |
| 1 | 40 C. & C., M. P., comp. | 750 |
| 1 | 40 Crocker-Wheeler, | 950 |
| 1 | 40 Eddy, M. P., comp. | 850 |
| 1 | 40 Keystone, M. P., comp. | 900 |
| 1 | 45 Am. Engine C., M. P. | 750 |
| 2 | 45 Edison, comp., self-oiler | 1000 |
| 1 | 45 Gen. Elec., M. P., comp. | 925 |
| 1 | 59 Eddy, M. P., comp. | 850 |
| 1 | 50 Triumph, M. P., comp. | 900 |
| 1 | 55 Fuller multipolar, comp. | 750 |
| 1 | 70 Western Electric, comp. | 585 |
| 1 | 75 C. & C., M. P., comp. | 525 |
| 1 | 80 C. & C., comp., self-oiler | 625 |
| 1 | 100 Edison, comp., self-oiler | 650 |
| 1 | 100 Commercial, M. P., comp. | 750 |
| 2 | 220 Eddy, M. P., comp, | 700 |
| 1 | 125 Thompson-Ryan, M. P. | 375 |
| 1 | 125 Siemens & Halske, M. P. | |
| 2 | 150 National, M. P., comp. | 350 |
| 1 | 200 Eddy, M. P., comp. | 500 |
| 1 | 300 Western Elec., M. P. | 480 |

## 500 TO 550 VOLT GENERATORS.

| K.W. | | Speed. |
|---|---|---|
| 1 | 60 Edison, comp., self-oiler, new armt. and commutator | 700 |
| 1 | 62 T.-H., D 62, s-o., comp. | 900 |

# DYNAMOS ❁ MONEY SAVERS ❁ ENGINES

**500 VOLT GENERATORS AND MOTORS**

2—500-K.W. Westinghouse 4 pole.
2—300-K.W. General Electric, 4 pole.
1—300-K.W. Westinghouse, 6 pole.
1—200-K.W. General Electric, 4 pole.
1—200-K.W. Edison bipolar.
2—175-K.W. Edison bipolar.
1—150-K.W. Westinghouse, 4 pole.
1—110-K.W. General Electric, 6 pole.
1—100-K.W. Westinghouse, 6 pole.
2—100-K.W. Edison bipolar.
1— 75-K.W. Westinghouse, 6 pole.
4— 75-K.W. General Electric, 4 pole.
3— 62-K.W. T.-H. bipolar.
*Complete stock of Motors.*

**220 VOLT GENERATORS AND MOTORS**

1—120-K.W. C. & C., 6 pole.
1—100-K.W. C. & C., 6 pole.
1— 50-K.W. Bullock, 4 pole.
1— 40-K.W. Crocker-Wheeler, 4 pole.
1— 16-K.W. Ft. Wayne, 4 pole.
1— 12-K.W. Keystone, bipolar.
*Complete stock of Motors.*

**100-125 VOLT GENERATORS AND MOTORS**

2—100-K.W. Edison bipolar.
2— 60-K.W. Edison bipolar.
2— 45-K.W. Edison bipolar.
4— 45-K.W. Westinghouse, 4 pole.
1— 40-K.W. C. & C., 4 pole.
1— 30-K.W. Loomis, 4 pole.
1— 35-K.W. Mather, 4 pole.
1— 21-K.W. Riker, 4 pole.
1— 17½-K.W. General Electric, 4 pole.
1— 15-K.W. Edison bipolar.
1— 12½-K.W. Card, 4 pole.
1— 8½-K.W. Edison bipolar.
2— 3-K.W. Westinghouse bipolar.
*Complete stock of Motors.*

**DIRECT CONNECTED UNITS**

200-K.W. Thompson-Ryan, 125 volt, d. c. McEwen tandem engine.
80-K.W. Jenney, 125 volt, d. c. Russell 4 valve engine.
50-K.W. Northern, 125 volt, d. c. Harrisburg standard engine.
50-K.W. Walker, 125 volts, d. c. Russell (new).
Two 50-K.W. American Ball, 220 volts, d. c. duplex and simple engines.
Two 42-K.W. Westinghouse, 220 volts, d. c. Alfrey engines.
30-K.W. Eddy, 125 volts, d. c. Watertown.
15-K.W. Crocker-Wheeler, 125 volts, d. c. N. Y. Safety.
7½-K.W. Northern, 125 volts, d. c. Hill (new).
6-K.W. Northern Electric, 125 volts, d. c. Hill (new).
4-K.W. Northern, 125 volts, d. c. Hill (new).
3-K.W. Northern, 125 volts, d. c. Hill (new).

**ALTERNATORS**

1—300-K.W. 25 cy., 3 ph., 6600 v. General Electric and 3 90-K.W. transformers, 6000/365 volts.
2—250-K.W. G. E., 60 cy. 3 ph. 10000 v.
1—100-K.W. G. E., 60 cy. 3 ph. 2300 v.
1— 75-K.W. Westinghouse, 60 cy. 2 ph. 2200 v.
1— 65-K.W. Stanley, 60 cy. 2 ph.
1— 60-K.W. G. E., 125 cy., s. ph., 1100 v.
2— 35-K.W. Westinghouse, 125 cy., s ph.

**ALT. CUR. MOTORS**

20-H.P. Westinghouse, 2 ph. 60 cy.
15-H.P. Westinghouse, 2 ph. 60 cy.
10-H.P. Excelsior, 8 ph., 125 cy.
7½-H.P. Westinghouse, 2 ph., 60 cy.
3-H.P. Westinghouse, 2 ph. 60 cy.
2-H.P. G. E., 3 ph. 60 cy. 110 v.

**Boilers THOMPSON SON & CO., 114 LIBERTY ST., N. Y. Equipments**

# MODERN ELECTRICAL MACHINERY FOR SALE.

**DIRECT CONNECTED UNIT, 220 volts**

50-K.W. American Ball Dynamo & Engine.

**10 VOLTS DIRECT CURRENT**
**Dynamos or Motors**

30-K.W. Bullock, M. P.
15-K.W. Eddy, M. P.
10-K.W. Eddy, M. P.
5-K.W. C. & C.
3-K.W. C. & C.
2-K.W. Lundell.
1-K.W. C. & C.

**500 VOLTS DIRECT CURRENT**
**Dynamos or Motors**

15-H.P. General Elec., M. P.
7½-H.P. General Elec., M. P.
5-H.P. Westinghouse.
5-H.P. Sprague.
2-H.P. General Elec.

**220 VOLTS DIRECT CURRENT**
**Dynamos or Motors**

40-H.P. Sprague, M. P.
25-H.P. Crocker-Wheeler, M. P.
20-H.P. Card.
15-H.P. C. & C.
15-H.P. Sprague, M. P.
10-H.P. General Elec.
10-H.P. Holtzer Cabot.
7½H.P. Card.
7½-H.P. Edison.
7½-H.P. C. & C.
5-H.P. Paragon, M. P.
5-H.P. Holtzer Cabot.
5-H.P. Crocker-Wheeler.
3-H.P. Diehl.
3-H.P. C. & C.
2-H.P. General Elec.
2-H.P. Diehl.
1½-H.P. C. & C.
1-H.P. Crocker-Wheeler.

**ALTERNATING INDUCTION MOTORS.**

**2 Phase, 60 Cycles, 220 Volts**

30-H.P. Type F Westinghouse.
15-H.P. Type C Westinghouse.
10-H.P. Type C Westinghouse.
7½-H.P. Type C Westinghouse.
5-H.P. Type C Westinghouse.
3-H.P. Type C Westinghouse.
2-H.P. General Elec.
1-H.P. Westinghouse.
½-H.P. General Elec., 220 or 110 v.
¼-H.P. General Elec.

**2 Phase, 440 Volts, 60 Cycles**

30-H.P. Westinghouse.
15-H.P. Westinghouse.
10-H.P. Westinghouse.
7½-H.P. Westinghouse.
5-H.P. Westinghouse.
3-H.P. Westinghouse.
1-H.P. Westinghouse.

**3 Phase, 60 Cycles**

5-H.P. Westinghouse, 220 volts.
2-H.P. Gen. Elec., 220 volts.
2-H.P. Westinghouse, 220 volts.
½-H.P. General Elec., 220 volts.
½-H.P. General Elec., 110 volts.

**1 Phase, 60 Cycles**

7-H.P. Wagner, latest type.
½-H.P. General Elec.
¼-H.P. General Elec.

**1 Phase, 125 Cycles**

3-H.P. Wagner, latest type.
2-H.P. Wagner, latest type.
1-H.P. General Elec.
½-H.P. Emerson.
1/10-H.P. Emerson.

Large stock of small motors, auto-starters, starting boxes, rheostats, switchboards, volt-meters, ammeters, etc.

**I BUY, RENT AND INSTALL.—GEORGE BENDER, 137 CENTRE STREET, NEW YORK.**

# BARGAINS IN
## (second-hand) ELECTRICAL MACHINERY

We do not offer old, worn out machines fit for the Junk pile, but the LATEST TYPES of the leading manufacturers.

## GREGORY ELECTRIC CO.
54-62 S. CLINTON ST. CHICAGO.

**Send for our Monthly Bargain Sheet showing NET prices—all machines fully guaranteed.**

| | K.W. | | Speed. |
|---|---|---|---|
| 1 | 75 | Akron, M. P., 6 pole | 900 |
| 2 | 75 | Bullock, multipolar | 900 |
| 2 | 75 | Gen. Elec. M. P., 4, comp. | 700 |
| 1 | 100 | Edison, comp. | 650 |
| 1 | 100 | Siemens & Halske, M. P. | 600 |
| 3 | 100 | Gen. Elec., M. P., 4, comp. | 650 |
| 1 | 100 | Westinghouse, M. P., 6 | 650 |
| 1 | 120 | Westinghouse, M. P. | 625 |
| 1 | 200 | Gen. Elec., M. P., 4, comp., s-o., three bearings | 400 |
| 1 | 200 | Thompson-Ryan, M. P. | 525 |

**ARC DYNAMOS.**

| | Lt. | C.P. | | Speed. |
|---|---|---|---|---|
| 1 | 35 | 2000 | T.-H., L D 2 ball | 820 |
| 1 | 45 | 1200 | Brush, No. 7. | 1050 |
| 1 | 50 | 1200 | T.-H., L D 12, new ball | 820 |
| 2 | 50 | 2000 | T.-H., M D 2, s-o., ring | 820 |
| 1 | 65 | 2000 | Brush, No. 8 | 950 |
| 1 | 75 | 1200 | T.-H., M D 12, s-o, | 820 |
| 1 | 75 | 1200 | Wood | 950 |
| 1 | 100 | 2000 | Wood | 600 |
| 1 | 125 | 1200 | Brush, 6.6 amp. | 700 |
| 2 | 125 | 2000 | Brush, 9.6 amp. | 500 |
| 1 | 125 | 1200 | Excelsior | 700 |

**220 TO 250 VOLT MOTORS.**

DIRECT CURRENT.

| | H.P. | | Speed. |
|---|---|---|---|
| 1 | 1 | Crocker-Wheeler, self-oiler | 900 |
| 1 | 1 | Commercial, self-oiler | 1200 |
| 1 | 1 | Paragon, self-oiler | 1100 |
| 1 | 2 | Edison, self-oiler | 1600 |
| 1 | 2½ | Gibbs, multipolar | 1250 |
| 1 | 3 | Gibbs, M. P. | 1400 |
| 1 | 3 | Westinghouse, M. P. | 1700 |
| 1 | 3½ | Paragon, self-oiler | 1000 |
| 1 | 5 | Western Electric, M. P. | 950 |
| 3 | 5 | Gibbs, M. P. | 1400 |
| 1 | 7½ | Western Electric, M. P. | 975 |
| 1 | 7½ | Towle, M. P. | 1050 |
| 1 | 7½ | Commercial, M. P. | 1300 |
| 1 | 7½ | Gen. Elec., M.P., form H | 800 |
| 1 | 10 | Sprague-Lundell, M. P. | 1175 |
| 1 | 10 | Keystone, M. P. | 1175 |
| 1 | 10 | Lundell, M. P. | 1060 |
| 1 | 15 | Crocker-Wheeler, M. P. | 810 |
| 1 | 15 | Card, M. P. | 700 |
| 1 | 15 | Westinghouse, M. P. | 1200 |
| 1 | 18 | Edison, 15-K.W. | 1150 |
| 1 | 25 | Western Electric | 525 |
| 1 | 25 | Keystone, M. P. | 725 |
| 1 | 25 | Eddy, M. P. | 725 |
| 1 | 25 | Diehl, M. P. | 750 |
| 1 | 30 | Crescent, M. P. | 800 |
| 1 | 40 | Western Electric, M. P. | 400 |
| 1 | 40 | Keystone, M. P. | 700 |
| 1 | 40 | Triumph, M. P. | 750 |
| 1 | 45 | Crocker-Wheeler, M. P. | 850 |
| 1 | 50 | C. & C., M. P. | 560 |
| 1 | 50 | Eddy, M. P. | 675 |
| 1 | 50 | Keystone, M. P. | 750 |

| | H.P. | | Speed. |
|---|---|---|---|
| 2 | 60 | Edison, self-oiler | 75 |
| 1 | 60 | General Electric, M. P. | 700 |
| 1 | 65 | Triumph, M. P. | 700 |
| 1 | 65 | Eddy, M. P. | 650 |
| 1 | 70 | Fuller, multipolar | 600 |
| 1 | 75 | Sprague, self-oiler | 500 |
| 1 | 85 | Western Electric | 500 |
| 1 | 100 | C. & C., M.P., 6 pole | 450 |
| 1 | 100 | C. & C., self-oiler | 450 |
| 1 | 125 | Edison, self-oiler | 550 |
| 1 | 135 | Commercial, M. P. | 675 |
| 2 | 150 | Eddy, M. P. | 600 |
| 2 | 200 | National, M. P. | 300 |

**500 TO 550 VOLT MOTORS.**

| | H.P. | | Speed. |
|---|---|---|---|
| 1 | 1 | Crocker-Wheeler | 1200 |
| 1 | 1 | Diehl, self-oiler | 1875 |
| 1 | 1 | New England | 1100 |
| 2 | 1½ | Crocker-Wheeler | 1550 |
| 2 | 2 | C. & C., self-oilers | 1350 |
| 1 | 2 | New England, self-oiler | 1200 |
| 1 | 2 | Crocker-Wheeler | 1100 |
| 1 | 2 | Lundell | 940 |
| 2 | 3 | Gen. Elec., type C E | 1800 |
| 2 | 3 | Crocker-Wheeler | 1100 |
| 1 | 3½ | Roth, self-oiler, M. P. | 950 |
| 1 | 4 | Triumph, M. P. | 1250 |
| 1 | 4 | Perrett, multipolar | 725 |
| 1 | 5 | Northern, M. P. | 1180 |
| 1 | 5 | Amer. Engine Co., M. P. | 1550 |
| 1 | 5 | Westinghouse, M. P. | 1500 |
| 3 | 5 | Crocker-Wheeler | 950 |
| 1 | 7½ | Northern, M. P. | 1500 |
| 1 | 7½ | Crocker-Wheeler | 1500 |
| 1 | 7½ | General Electric, M. P. | 1600 |
| 1 | 10 | Perrett, M. P. | 600 |
| 1 | 10 | Northern, M. P. | 1350 |
| 1 | 10 | Triumph, M. P. | 1100 |
| 1 | 10 | Crocker-Wheeler | 1275 |
| 1 | 10 | General Electric, M. P. | 1400 |

| | H.P. | | Speed. |
|---|---|---|---|
| 1 | 15 | Kester, M. P. | 1250 |
| 1 | 15 | C. & C., self-oiler | 975 |
| 1 | 15 | Perrett, M. P. | 1100 |
| 1 | 18 | T.-H., D 15, self-oiler | 1550 |
| 1 | 20 | Kester | 1400 |
| 1 | 20 | S. & H., M. P., Churchward | 900 |
| 1 | 20 | Perrett, M. P. | 700 |
| 1 | 20 | Commercial, M. P. | 900 |
| 1 | 25 | New England, multipolar | 900 |
| 1 | 25 | Card, multipolar | 500 |
| 1 | 35 | Card, M. P., self-oiler | 775 |
| 1 | 40 | Wood, multipolar | 750 |

**ALTERNATING CURRENT MOTORS.**

SINGLE PHASE. 125-133 CYCLES.

| | H.P. | | Speed. |
|---|---|---|---|
| 1 | ½ | Wagner, 104 v., aut. | 2000 |
| 1 | 1 | Fort Wayne, 104 volts | 2500 |
| 1 | 1 | Wagner, 208 volts, aut. | 2000 |
| 2 | 1½ | Wagner, 208 volts, aut. | 2000 |
| 1 | 5 | Wagner, 104 volts, aut. | 2000 |
| 1 | ½ | Phillips, 104 volts | 1800 |
| 1 | ½ | Holtzer-Cabot, 104 volts | 2500 |
| 1 | ½ | Emerson, 104 volts | 2000 |
| 1 | ½ | Stanley, 104 volts | 2000 |
| 1 | ½ | Wagner, 104 volts, aut. | 2000 |
| 1 | 1 | Fort Wayne, 104 volts | 2500 |
| 1 | 1 | Wagner, 208 volts, aut. | 2000 |
| 1 | 1½ | Wagner, 208 volts, aut. | 2000 |
| 1 | 5 | Wagner, 104 volts, aut. | 2000 |

SINGLE PHASE. 60 CYCLES.

| | H.P. | | Speed. |
|---|---|---|---|
| 2 | ½ | Phillips, 104 volts | 1800 |
| 1 | ½ | Phillips, 208 volts | 1800 |
| 3 | ½ | Phillips, 104 volts | 1800 |
| 3 | ½ | Phillips, 208 volts | 1800 |
| 1 | 1 | Phillips, 208 volts | 1600 |
| 1 | 1 | Phillips, 104 volts | 1600 |
| 3 | 1 | Wagner, 208 volts | 1800 |

| | H.P. | | Speed. |
|---|---|---|---|
| 1 | 3 | Wagner, 208 volts | 1800 |
| 1 | 7½ | Wagner, 104 volts | 1800 |
| 1 | 15 | Wagner, 104 volts, aut. | 1200 |
| 2 | 30 | Wagner, 104 volts, aut. | 1200 |

THREE PHASE. 125-133 CYCLES.

| | H.P. | | Speed. |
|---|---|---|---|
| 1 | 3 | General Electric, 110 volts | 1875 |

TWO PHASE. 60 CYCLE.

| | H.P. | | Speed. |
|---|---|---|---|
| 1 | 1 | West., type C, 110 v. | 1800 |
| 1 | 1 | West., type C, 200 v. | 1700 |
| 1 | 2 | Gen. Elec., 220 v. | 1800 |
| 1 | 3 | Stanley, 500 v., with condenser | 1860 |
| 1 | 7½ | West., type B, 400 v. | 1200 |
| 1 | 20 | West., type C, 208 v. | 1120 |
| 4 | 50 | West., 400 v., type B. | 900 |
| 1 | 75 | West., 400 v., type B | 900 |
| 2 | 100 | West., 400 v., type B | 720 |

THREE PHASE. 60 CYCLE.

| | H.P. | | Speed. |
|---|---|---|---|
| 2 | 1 | Gen. Elec., 110 v. | 1800 |
| 1 | 2 | Gen. Elec., 220 v. | 1800 |
| 1 | 3 | Gen. Elec., 104 v. | 1875 |
| 1 | 5 | Gen. Elec., 110 v., type T I | 1200 |
| 1 | 10 | Gen. Elec., 110 v., form L | 900 |
| 1 | 15 | Gen. Elec., 110 v., form L | |

**ATTENTION, MANUFACTURERS.**

**Extra Slow Speed Motors, 220 volts, direct-current, suitable for operating drills, lathes, presses and tools of all descriptions electrically—these machines are all in stock and for sale cheap.**

| | H.P. | | Speed. |
|---|---|---|---|
| 1 | ½ | Maine, M. P. | 450 |
| 1 | ¾ | Maine, M. P. | 400 |
| 4 | ¾ | Maine, M. P. | 260 |
| 1 | 1 | Maine, M. P. | 500 |
| 1 | 1 | Maine, M. P. | 450 |
| 1 | 1½ | Maine, M. P. | 500 |
| 4 | 2 | Maine, M. P. | 260 |
| 1 | 3 | Storey, variable speed 300-1500 | |
| 1 | 3 | Keystone, compound | 650 |
| 1 | 3½ | Eddy, M. P. | 400 |
| 1 | 4 | Commercial, M. P. | 450 |
| 5 | 5 | Western Electric, M. P. | 950 |
| 1 | 5 | Eddy, M. P. | 300 |
| 3 | 5 | Belknap, M. P. | 230 |
| 1 | 6½ | Jenney, M.P., back geared, speed of shaft | 440 |
| 1 | 7½ | Milwaukee, M. P., series, crane type, grease cup | 600 |
| 1 | 8 | Crocker-Wheeler, series, crane type | 900 |
| 1 | 8 | Maine, M. P. | 200 |
| 1 | 10 | Bernard, M. P. | 170 |
| 3 | 10 | Bernard, M. P. | 130 |

**All machines fully guaranteed.**

## FOR SALE.

DIRECT CONNECTED.

30-K.W. Eddy dynamo to Watertown engine, 110 volts.
10-K.W. Westinghouse dynamo to Armington & Sims engine, 110 volts.
10-K.W. Westinghouse dynamo to Westinghouse engine, 110 volts.
80-Amp. Edison dynamo to Brotherhood engine, 80 volts.
20-H.P. Elektron 220 volt motor to Morse Williams freight elevator.

BELTED.

60-amp. Crocker-Wheeler to Herresoff engine, 110 volts.
2000 volt Electro Dynamic arc dynamo, 10 amperes.
500-Lt. Edison dynamo, 110 volts.
60-amp. Westinghouse dynamo to Westinghouse engine, 110 volts.
35-amp. Sprague dynamo to Hornby Ackroyd oil engine.
600-Lt. Weston dynamo, 110 volts.
500-Lt. Edison Dynamo, 110 volts, D.C. to Brotherhood engine.
400-Lt. Excelsior dynamo, 110 volts.
45-H.P. C. & C. motor, 230 volts.
30-H.P. C. & C. motor, 230 volts.
15-H.P. Thomson-Houston motor, 500 volts, with spare armature.
15 General Electric, 2-H.P., 220 volt motors.
12 Siemens & Halske 5-H.P., 220 volt motors, 220 volts, 1550 R.P.M.
2 search lights.

These motors are dust proof and series wound.

Large stock of smaller dynamos and motors.

Repairing of electrical machinery in all its branches.

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16 and 30x48 Cooper cross compound condensing Corliss engine, 500 H.P. at 150 lbs. steam.
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15½x16 New York Safety automatic engine, direct connected to 100-K.W. General Electric 125 v. generator.
16x16 Ideal engine, direct connected to 100-K.W. Western Electric 115 v. generator.
150-K.W. Ft. Wayne compound alternator, 16,000 alternations, single phase, 2,200 v.
100-K.W. Edison, 125 v., direct current.
175-K.W. Edison, 250 v., direct current.
30-K.W. Western Electric, 220 v., direct current.

Write for price list No. 43 of dynamos, engines and boilers.

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250-H.P. 18x48 Lane and Bodley Corliss.
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200-H.P. 12 and 22x42 Atlas Compound Corliss.
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175-H.P. 16x42 Putnam Corliss.
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125-H.P. 14x36 Allis Corliss.
125-H.P. 14x36 Putnam Corliss.
100-H.P. 12x36 Harris Corliss.
85-H.P. 12x30 Lane and Bodley Corliss.
650-H.P. 28½x52 Buckeye Automatic.
450-H.P. 24x48 Buckeye Automatic.
400-H.P. 16½ and 28½x27 Buckeye Compound Aut.
250-H.P. 16 and 27x16 Westinghouse Compound.
150-H.P. 15x14 Ideal Self Oiling Automatic.
100-H.P. 13x12 Ideal Self Oiling Automatic.
90-H.P. 12x20 Atlas Side Crank Automatic.
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40-H.P. 9x13 Frost Side Crank Automatic.

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1—350-H.P. Babcock and Wilcox Boiler, 150 lbs.
1—280-H.P. Babcock and Wilcox Boiler, 150 lbs.
2—265-H.P. Babcock and Wilcox Boilers, 150 lbs.
3—265-H.P. Babcock and Wilcox Boilers, 135 lbs.
1—175-H.P. Babcock and Wilcox Boiler, 125 lbs.
1—172-H.P. Babcock and Wilcox Boiler, 130 lbs.
1—250-H.P. Cahall Vertical Boiler, 160 lbs.
1—72x18 Tubular Boiler, 130 lbs.
1—72x18 Tubular Boiler, 125 lbs.
7—72x18 Tubular Boilers, 100 lbs.
3—72x16 Tubular Boilers, 100 lbs.
8—66x18 Tubular Boilers, 100 lbs.
3—66x16 Tubular Boilers, 100 lbs.
1—60x18 Tubular Boiler, 100 lbs.
4—60x16 Tubular Boilers, 100 lbs.
2—60x14 Tubular Boilers, 120 lbs.
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Armature Winding, Armature Coils. Commutators, Gears and Pinions.

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(with or without real estate) no matter where it is or what it is worth. Send description, state price, and learn how. I have a special department for buying and selling electric light and gas plants. If you want to buy, tell me your requirements. W. M. OSTRANDER, 196 North American Building, Philadelphia.

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Complete new apparatus embodying all the most recent improvements in machinery employed in the manufacture of incandescent electric lamps. Will guarantee lamp manufacturers results as to cost and quality. Address No. 1158, care Electrical World and Engineer, New York.

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Tickets to the Northwest via Chicago and The North-Western Line are on sale by all ticket agents.

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PASSENGER TRAFFIC MANAGER,
CHICAGO.

PROPOSALS will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 12 o'clock noon, February 23, 1904, and publicly opened immediately thereafter, to furnish at the navy yards, Mare Island, Cal., and Puget Sound, Wash., a quantity of lighting wire, electrical supplies, hand scrub brushes, corn brooms, Portland cement, cotton twine, curled hair, mattress ticking, linen, furniture, belting, white ash, pine, redwood, thimbles, files, hardware, machine tools, galvanized sheet steel, magnesia, rubber sheet packing, hose, alcohol, turpentine, brass pipe, wrought-iron pipe, pipe fittings, rubber coupling washers, baseballs, athletic goods, stationery and cotton waste. Blank proposals will be furnished upon application to the navy pay offices, San Francisco, Cal., and Seattle, Wash. H. T. B. HARRIS, *Paymaster General, U. S. N.* 1-18-04

PROPOSALS will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 12 o'clock noon, March 1, 1904, and publicly opened immediately thereafter, to furnish at the navy yards, Norfolk, Va., Charleston, S. C., and Port Royal, S. C., a quantity of electric blowers, electric fans, electric traveling crane, split pulleys, hardware, railroad track tools and materials, lamps, lanterns, lantern globes, drills, machinists' tools, shovels, leather belting, roofing felt, hammock hooks, lumber, fire brick, nickel steel, galvanized sheet steel, copper, zinc, hose, flax packing, kerosene, sperm oil, gasoline, petrolatum, rosin, turpentine, tar, shellac, bath brick, pumice stone, brass pipe, pipe fittings, stationery, marine cement, oakum, lenses, cotton waste, wheelbarrows, target switch stands, push cars, and a foundry cupola. Blank proposals will be furnished upon application to the navy pay offices, Norfolk, Va., Charleston, S. C., and Port Royal, S. C. H. T. B. Harris, Paymaster General, U. S. N. 1-29-04

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Immediate delivery. 70-K.W., 250 volts, 600 R.P.M. 4 pole Type G, self-oiling Eddy dynamo, one of their latest and best machines in thorough repair Commutator never turned. Price $600.00. J. L. Gleason & Co., 143 Federal St., Boston, Mass.

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Electric light plant in town of 1,000 population. In fine shape and on sound financial basis. I did not want to take it, but was obliged to and now want to sell it. New generator and thoroughly overhauled since taking possession. E. E. Secor, Buffalo Center, Iowa.

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5—60-K.W. 125 volt bi-polar Edison 700 R.P.M.
1—55-K.W. Type MP 6-55-875 R.P.M. Gen. Elec., compound wound.
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2—40-K.W. 125 volt Type CCD Class 35-D compound wound Crocker-Wheeler.
1—30-K.W. 125 volt multipolar compound wound Westinghouse.
5—25-K.W. 125 volt compound wound Edison.
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All horse-powers, voltages, cycles and phases.

**DIRECT CURRENT MOTORS.**

All sizes, voltages and best up-to-date makes.

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1—22x42 Harris Corliss.
1—21x18 Armington & Sims.
1—18x48 Knowlson & Kelly Corliss.
1—18x48 Allis Corliss.
1—16"x36" Whitehill.
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2—16x16 Ball & Wood.
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1—14½x24 Buckeye Tangye frame.
1—14x16 New York Safety Power Co.
2—13x18 Harrisburg Ideal.
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**Compound.**

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1—20&36x48 Tandem Fitchburg Corliss.
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4—16&32x48 Tandem Cooper Corliss.
1—16&28x18 Tandem Erie Ball.
1—16&28x16 Cross Erie Ball.
1—16&26x17 Tandem McIntosh & Seymour.
1—15&25x16 Cross Erie Ball.
1—15&23x17 Tandem McIntosh & Seymour.
1—14&25x16 Ball & Wood, self contained.
2—13&23x18 Tandem Williams.
1—13&20½x15 Cross Armington & Sims.
1—12&21x16 Cross Erie Ball.
1—18&30x16 Westinghouse.
1—16&27x16 Westinghouse.
1—14&24x14 Westinghouse.
1—13&22x13 Westinghouse.

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(*Continued from page 44.*)

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WANTED.—In New York office, draughtsman who is a Remington typewriter, too; paid *pro rata;* minimum guarantee, $40 each month; state experience. Address No. 1304, care Electrical World and Engineer, New York.

WANTED.—Estimator; man familiar with plans for electrical wiring; state experience and salary expected. Address No. 1303, care Electrical World and Engineer, New York.

WANTED.—Foreman or assistant superintendent for paper insulated cable shop; knowledge of lead and other electrically insulated cables necessary; salary $2500. Address No. 1309, care Electrical World and Engineer, New York.


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WANTED.—Electricians in charge of isolated plants to represent one of the finest makers of incandescent lamps, on exceptionally liberal terms; good money in it for the right parties. Address No. 1293, care Electrical World and Engineer, New York.


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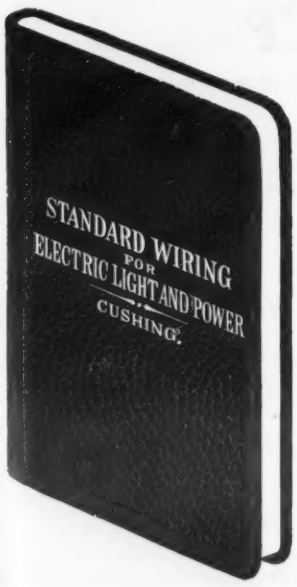


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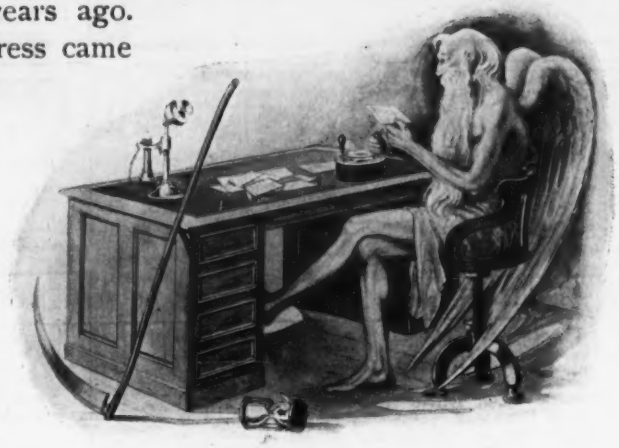

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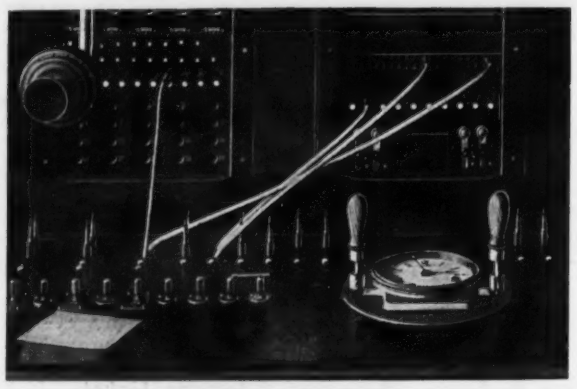

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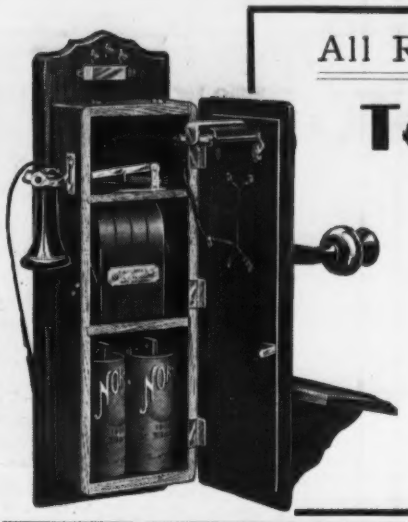

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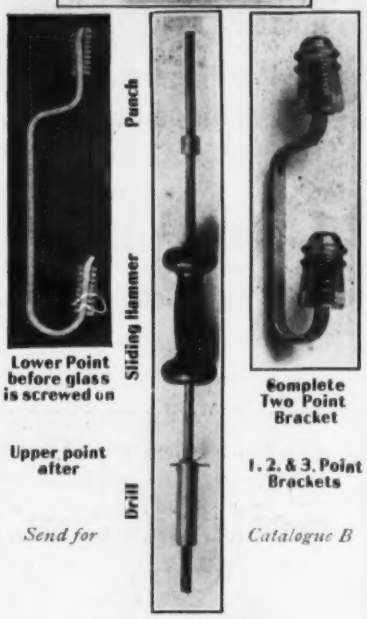


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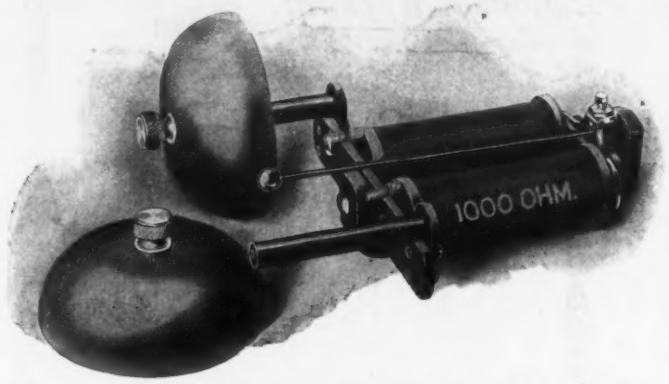


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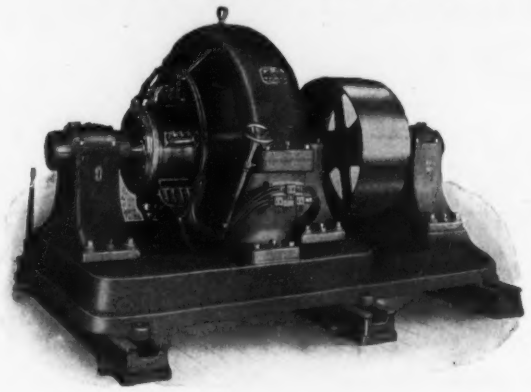

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